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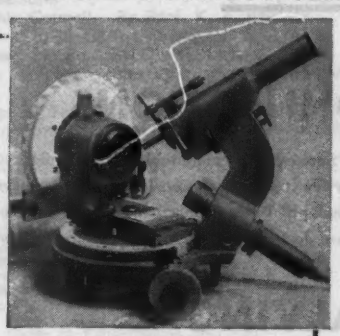

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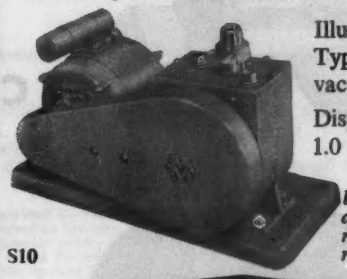

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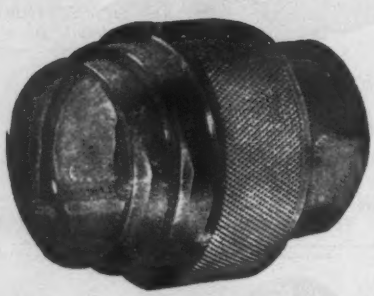

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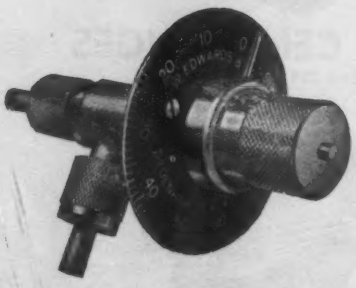

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THE COUNCIL FOR NATURE

THIS year, which sees the celebration of the centenary of the Darwin–Wallace joint statement on natural selection, will also witness, more quietly, several consequences of that statement. Darwin's emphasis upon observation in the field and the importance of searching the rocks for fossils, gave a new stimulus to natural history, and it must be more than mere coincidence that the decade following that statement and, afterwards, the publication of the "Origin of Species"—saw the formation in Britain of an impressive number of naturalists' societies, mechanics' institutes and museums. Clearly, there was then a determination among ordinary people to examine for themselves the facts of Nature.

The pendulum of public interest has swung many times since then, and may currently be said to incline more favourably towards archæology. None the less, many of the societies and field clubs so founded linger on, though in but few is there much evidence of the enthusiasm in which they were so bravely launched. Records testify to the passing away of several proud names and the cessation of journals that were once useful and of wide circulation.

These facts are of importance, for it is clear that there is still need of their former activity. The statement that "all data in natural history are vanishing data" has seldom been so obviously true. The need to collect, collate and to conserve the materials of Nature is urgent. Even such tasks as the observation of the pollution of streams and the deterioration of roadside verges, well within the competence of local societies, are being neglected. Unfortunately, even among continuing bodies, activities seem to be desultory. Useful surveys are begun but fail to be maintained. It is true that there are some few notable exceptions in this depressing picture, and that there are 'unions' of scientific societies, regional affiliations which in some instances, as in the South Eastern Union, have organized programmes and an annual conference.

Naturalists are not alone in facing these problems. After the Second World War, the archæologists took stock of their affairs and, after consultation with local societies, university extra-mural departments and other interested organizations, on a broad and democratic basis, formed the Council for British Archæology, now so ably led by Prof. W. F. Grimes. These and other considerations have suggested to the Society for the Promotion of Nature Reserves that something could be done equally for the propagation and revival of interest in Nature, for the formation of local nature reserves, and the encouragement and co-ordination of appropriate societies.

As a result of these deliberations, a small working party was formed, including representatives of the Society for the Preservation of Nature Reserves, the Council for Field Studies, the Nature Conservancy, several societies and naturalists' trusts, and plans were made for the formation of a Council for Nature. These plans were made public and were freely discussed at a special meeting held in the rooms of the Linnean Society on February 19, and as a result a Council for Nature and a provisional committee were set up under the presidency of Lord Hurcomb and the chairmanship of Sir Landsborough Thomson. The immediate task of the committee is to consult the wishes and investigate the needs of local societies and regional organizations.

This inauguration, which was thought by some to be rather premature, is in fact most opportune. The Carnegie United Kingdom Trust has recently evinced an interest in the amateur in field studies of archæology and natural history, and has discovered the difficulty of finding a representative body with which to discuss aims and methods. As a direct consequence, the British Association has accepted a grant from the Trust to undertake the preparation of a directory of cognate scientific societies. This work is in active progress, its committee endeavouring to steer a course between the eight hundred or so societies that are strictly relevant and the two thousand or more that have a tenuous connexion, usually a sporting interest, with some aspect of botany and zoology. There is no doubt that this directory will provide a valuable basis for consulting all the societies claiming activity in some field of Nature.

But societies, even giving them their full due, are not the only interested parties. There are national bodies, some of which have expressed a desire to co-operate fully with the new Council, that are concerned with much wider aims. The advance of science is frequently a mixed blessing: the claims of technology being made, and sometimes carried, at the expense of natural amenities. Reasonable compromise is often possible and occasionally takes place, but who can really speak for the whole body of naturalists? With no active voice at the moment, representations made on reasonable grounds are sometimes feeble, often conflicting and frequently ill-argued. The Nature Conservancy, powerful and experienced and friendly to local interests, is none the less a government department, and is hampered in its dealings with other government departments.

The Council for Nature has thus a primary function to fulfil: that of watchdog—but not necessarily that of unflinching opponent—of all schemes alleged to spoil the countryside. It is important to stress that the Council will not exist as a purely restrictive body. The national parks of Britain, with all their problems caused by the access of some members of the public to places of beauty, may welcome its aid. Public education and information may be found, in the long run, more rewarding than compulsion or interference with public freedom. The Council of Nature is, by

its origin, favourable to the interests of the amateur, the hiker, the photographer and the bird watcher—the general public of the parks. As yet, in Britain, we lack the service of guides and instructors, so commendably provided by the National Parks Organization of the United States. We would commend the American service to the new Council, and suggest that co-operation and some early exchange of staff would be rewarding.

Education in Nature need not, however, begin either on the hillside or by the seashore. There is need for instruction in schools from members, say, of a special panel of lecturers. Courses for adults could be arranged in evenings in museums and colleges, clubs and societies. More general education by books, pamphlets, guide leaflets (as in the United States), by television and radio could do—and already is doing—much to make an intelligent and constructive approach to the study of Nature and to denigrate careless and destructive actions.

Much of this day-to-day work cannot, of course, be done best by a central body, and much will depend and devolve upon local groups, trusts and societies; but it must be rationalized and co-ordinated. Consideration of surveys that should be undertaken by societies can be made, programmes devised, inaugurated and some continuity of effort guaranteed. This should make for efficiency and economy in general work on natural history.

The foundation of local naturalists' trusts, on the lines of those in Lincolnshire, will obviously be one of the objects deserving the Council's support. Attention must also be paid to the lessening skills in certain aspects of amateur zoological and botanical work that seem to threaten accomplishment. Here instruction, encouragement and, perhaps, even subsidy can be given.

It is obvious that a wide field of liaison with societies, trusts and local interests on one hand, and with the Nature Conservancy on the other, can be effected, and this the Conservancy would no doubt welcome. Legal services too, where necessary, can be organized. Close co-operation with the British Association, the Council for the Preservation of Rural England, the similar council for Wales, the Council for Field Studies, and university departments can be assured from their representatives on the provisional committee. Conservation is still in its youth in Britain. Much needs to be done to make its aims more clear to the general public and to remove that feeling of interference that the name seems to convey in some quarters.

None of this work, least of all a journal devoted to its interests, can be done without adequate finance. The Society for the Promotion of Nature Reserves has generously promised to bear much of the expense of the inaugural years. When the aims of the Council become more legally defined in its constitution and more clearly appreciated, it may be that one of the benevolent financial trusts may see in the new body the organization that naturalists and nature-lovers have long desired. What must be clearly emphasized is that the Council for Nature proposes to act as co-ordinator and agent, as protector, and not suppressor, of local interests. There is room in it for all who love Nature and who respond to Emerson's lines:

"Hast thou named all the birds without a gun?
Loved the wood-rose, and left it on its stalk?"

The title of that poem might well be the motto of the Council for Nature itself—Forbearance.

PRACTICE FORESHADOWING SCIENCE

Robert Bakewell

Pioneer Livestock Breeder. By Prof. H. Cecil Pawson. Pp. xv+200+10 plates. (London: Crosby Lockwood and Son, Ltd., 1957.) 25*s*. net.

VERY often old farming books propound theories or describe practices that seem to indicate that their writers had some inkling of the principles of modern science. It is extraordinarily easy to accept this conclusion, because it is very difficult to re-create in one's mind the condition of knowledge at a given date. When a great innovator like Robert Bakewell has written nothing about his theories, and left no record of his practice, this difficulty becomes almost insuperable.

Bakewell left the record of his success in the animals he produced—horses, cattle, sheep and pigs; but he was secretive about his methods. When Prof. H. C. Pawson discovered the letters published here for the first time, there was some hope that more would be revealed about the way in which Bakewell bred such fine animals, that made him so famous, both in his own day and in the esteem of posterity. In this respect the letters are disappointing, but they have provided a good reason for an attempt to write a monograph on this important man, about whom only a few brief periodical appreciations have been written in the past. The character of the man and some of his business methods are more closely delineated in these new letters.

The additional resources provided by the fodder crops, introduced from the Low Countries in the seventeenth century, and developed in English farming in the eighteenth century, had provided a means of feeding better cattle. Before that time there were so-called breeds, but these animals were all subjected to restricted nutrition in the winter, as indeed their owners were. The consequence was that, while almost every county claimed to have a breed of its own, the greatest distinctions that could be drawn were in colour, shape of horn, and perhaps size. Between the haphazard methods of breeding and poorness of feed all sank to a poverty line, and were brought to a low and equal level of comparative uniformity.

With better feed, especially during the winter months, it became possible to maintain the animals in thriving condition throughout the year. If the best of them were selected for breeding, new standards would be set up, and breeds defined. Enclosed pastures made it possible to select breeding material.

Bakewell was not the first man to take advantage of these new developments, but he was one of the most distinguished. Being the tenant of enclosed fields, and having the natural flair that is the most valuable possession of a livestock breeder, he was able

to produce an outstanding race of Longhorn cattle, of New Leicester sheep and 'black' horses. The economic conditions of the time, too, encouraged his efforts, as those of others, because there was a rising demand for the meat-producing animal.

Of necessity Bakewell was an empiricist, but he was of an original cast of mind, and Prof. M. McG. Cooper, who contributes to this book a modern evaluation of Bakewell's work, estimates that his ideas were well over a century in advance of his time. So far as can now be learned, the main principles of Bakewell's breeding system was a degree of in-breeding which some have thought excessive, combined with what is now known as the progeny test, something largely neglected in the intervening century and a half. The results were so remarkable that Bakewell earned an international reputation in his own lifetime, and was sought out by visitors from all over the world. He could not, of course, have explained what he did in terms of modern genetical science, but he used the observed results of careful experiments. No doubt intelligent farmers had been in the habit, when they could, of selecting their best animals to breed from in the hope that like begat like, but Bakewell led the way towards modern breeding. His new water meadows added to his supply of 'natural' feeding stuffs. It is unfortunate, as Prof. Pawson says, that his records, if he ever kept any other than in his memory, have vanished, and that little is known of his early life. Nevertheless, this book forms a welcome addition to our knowledge of one of our greatest farming pioneers. The fact that it adds little to an exposition of his methods in a more explicit manner is no fault of the author; the necessary evidence does not, in fact, exist.

G. E. Fussell

PRINCIPLES OF ANALYSIS

Quantitative Inorganic Analysis

By Prof. G. Charlot and Denise Bézier. Translated by Dr. R. C. Murray. Pp. x+691. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1957.) 84*s*.

THE chief aim of this unusual book seems to be to stimulate an interest in fundamental principles rather than to provide detailed descriptions of reliable analytical methods. The authors state that their book is no replacement for specialized works.

In the first half of the book the theoretical aspects of chemical analysis are emphasized, particularly in relation to physico-chemical methods: the thirty-three chapters deal with a variety of subjects, including not only those usually found in works on chemical analysis but also, as examples, with statistical methods, determinations in solvents other than pure water, electrography, coulometry, and the use of radioactivity in analysis. Some practical details are included, though the treatment of some subjects, such as emission spectrophotometry, is very brief and the reader is left to use the many references provided.

Part 2 of the book deals with the determination of sixty-five of the chemical elements and contains much succinct information, though here again the practising analyst will often need to refer to the many original papers and specialized books listed.

The authors have attempted to provide comprehensive, though sometimes very brief and uncritical information and some blemishes are inevitable. As examples, one would hesitate to rely on ferrous ammonium sulphate for the standardization of dichromate, and one wonders why on p. 430 the gravimetric determination of manganese as pyrophosphate is omitted, while the poor method based on weighing as trimanganic tetroxide is mentioned. There is no mention on p. 546 of the gravimetric method for the determination of potassium based on weighing platinum after a chloroplatinate precipitation. One is surprised to read on p. 392 that the determination of bromide in the presence of chloride is difficult; no mention is made of the work of Haslam *et al.* (*Analyst*, 75, 343; 1950).

However, despite its defects, the book should encourage the student of analytical chemistry to strive for a better understanding of his work and to explore the possibilities of new methods.

C. O. Harvey

REASON AND CONTROVERSY

Methods and Criteria of Reasoning

An Inquiry into the Structure of Controversy. By Rupert Crawshay-Williams. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. viii+296. (London: Routledge and Kegan Paul, Ltd., 1957.) 32*s*. net.

AS its somewhat pretentious title indicates, this book deals with the various ways in which disagreements and controversies arise, and in which they can be resolved. Much of the argument expounds and applies ideas that have dominated recent philosophy; unfortunately it is conducted in a repetitious manner, and in a terminology that does not conform to the standards of precision which it, itself, desiderates. Some good points are made on the way, particularly concerning that fashionable shibboleth 'ordinary language'. Mr. R. Crawshay-Williams explicitly confines himself to what he calls 'testable' statements; he is not concerned with those which lack a decision-procedure for their truth or falsity, although he rightly says that these may be illuminating or interesting in some ways. This restriction of topic, quite legitimate in itself, involves a notion of testability which is too *simpliste*. It is baldly asserted, on p. 258, that the only kind of evidence that can be adduced for any belief is 'scientific' evidence; this view, which recalls the logical positivism of the 'twenties, now requires defence, and should not be taken for granted.

If the word 'science' is given such a wide meaning that it becomes vacuous, the principle is trivial; if used in its proper sense, the principle should be stated in a way that faces up to recent criticisms of the verification principle, contemporary developments in ethics, and, indeed, the existence of history as a form of knowledge. Crawshay-Williams's task is to show how, by redefinition and explication, we can render indeterminate, and hence controversial, statements into determinate and testable ones. He discusses examples of scientific controversy ('Are viruses molecules or organisms?', 'Is aphasia a pure or complex disorder?') in an interesting way which illuminates the conceptual tangles at issue, but which does not clarify or reinforce the main thesis. This is that the meaning of all descriptive statements is

relative to both the context in which they are made, and to the facts in question. No description can be complete, or true, in itself, that is, out of relation to our cognitive interests; these determine the relevant area of fact, which in turn determines the truth or falsity of the description. Empirical discourse is described as a function of three variables: the subject matter (S), the description (D), and the context of the description (C). A complete analysis of an empirical statement is of the form 'S is D in C'; the correctness of a description depends not only upon facts but also upon the context in which it occurs. If Smith arrives 0·5 sec. before Jones, we correctly say that they arrived 'at the same time' in the context of a party, but it would be wrong to say that they had dead-heated in the context of a race.

This is important and true, but Crawshay-Williams's account of it is not satisfactory. Misgivings can be indicated only briefly. (1) It is assumed that empirical assertions are descriptions; this is not so, because existential statements, which are certainly empirical, are not descriptions, and only in rare cases are they dependent on context ('Is there a ghost in Hamlet?'). Ordinary existential statements like 'There is a fox in the covert' seem to be complete, and true or false, without reference to context. (2) The words 'sentence' and 'statement' are used as if they were synonymous, or nearly so; there is a mistake here, and it leads Crawshay-Williams into muddles. He distinguishes between sentence-token and sentence-type (p. 213), statement and statement-type (p. 72–3), and sentences and propositions (p. 85). The relations between all these are not explained, and hence there is an obscurity at the heart of the argument. (3) The words 'context' and 'criterion' are distressingly vague. The former is used to mean both 'universe of discourse' and 'purpose', while it is not clear whether 'criterion' is used to refer to the truth or to the meaning of a statement. It is regrettable that a book in this well-known series should contain elementary mistakes of grammar; three sentences conclude with the phrase "being paid attention to". C. K. Grant

A NEW APPROACH TO ELECTRICITY

Currents, Fields, and Particles

By Prof. Francis Bitter. Pp. xiv+600. (Cambridge, Mass.: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 68s.

THIS excellent book represents the second-year work of a two-year course developed by Prof. Bitter at the Massachusetts Institute of Technology, and "based on atomic physics". Sorted out into a more traditional sequence, the contents are similar to those of many books on electricity and optics available for this level, and the standard is at least as high. The arrangement and presentation are strikingly original, for the author has woven modern ideas into the whole of the book, so that the reader assimilates them as he goes through it instead of colliding with them towards the end. The general attitude of the author is like that of R. W. Pohl, to whom indeed he pays tribute, and the work carries the same persistent challenge to think in terms of fundamental physics as Pohl's books did nearly thirty years ago.

The first four chapters centre on the electric field and the electrical structure of matter, ionic and electronic conduction, and the detailed behaviour of dielectrics. It is interesting here to see how fully Rutherford's experiments on α-particle scattering, and, later, various uses of the RC circuit are discussed; these embody most important points of principle. On the other hand, the oscilloscope, the Van de Graaff machine, the linear accelerator, and other rather technical applications are indicated or outlined only. The main object, the study of the interaction between electric field and charged particle, is pursued firmly without digression.

The magnetic field is introduced (after a brief discussion of the unreliability of the magnetic dipole as a test object, and the rather too recent discovery of the utility of the proton for this purpose) in terms of the force experienced by a moving charge. The experimental justification for this is that the cyclotron, the velocity-selector, and measurements of e/m are known to work. Here the more elderly reader, who has after a struggle abandoned magnetostatics and accepted Ampère's experiments as a starting-point, is made to think very hard. Prof. Bitter is quite clear about the two main difficulties to be resolved. First, that the force between two current-carrying conductors is a very different matter from the force between two charged particles in motion; and also that we have no direct experimental knowledge about the field due to a single moving electron. He writes down the expression for the field due to a moving charge, and states that this is *consistent* with all experiments done using current-carrying conductors. This seems quite a revolutionary approach; but after all, only one sound experimental link between charged particle and magnetic field is really needed, and the rest is a deductive chain. It is unlikely that teaching laboratories will ever replace their current-balances by cyclotrons, and of course the author's treatment does not imply this kind of thing. The point is that the basic concept is taken to be the interaction between magnetic field and charged particle, rather than the force between pole and pole or between circuit and circuit. The determination of the ampere is explained clearly; and this chapter can be particularly commended for its presentation of what is at all levels one of the most difficult matters to teach.

From the next three chapters, on electromagnetic induction, electrical oscillations and electromagnetic waves, a few instances only need be given of their quality. The detailed treatment of the energy relations in an inductor, the very full account of the Hall effect, and the opportunity taken in the section on resonance to explain electron resonance and nuclear magnetic resonance in materials, are examples.

It would seem logical, and a great economy of effort, to treat light after the general properties of electromagnetic radiation have been mastered. Chapters 9 and 10, which deal with geometrical and physical optics, respectively, at first seem rather too elementary, for the electromagnetic theory is not, in fact, employed. But these chapters fit into the pattern of those that follow, when spectroscopic evidence for the location of energy-levels, the diffraction of particles, the black-body spectrum, and other topics requiring a background of optical knowledge appear. The beautiful frontispiece, of spectra taken using a grating crossed with an échelle, is, incidentally, not explained until the appendix.

The final chapters, starting with a review of the experimental basis of atomic physics, cover wave mechanics, atomic structure and nuclear physics.

The problems at the ends of the chapters themselves make interesting reading, ranging from calculations on the Massachusetts Institute of Technology cyclotron magnet and the interpretation of tables of experimental results to some very searching tests of a student's capacity to handle complicated data.

The book can be recommended with enthusiasm as an outstandingly clear explanation of fundamental principles in present-day terms. G. R. NOAKES

THE SOLAR CORONA WITHOUT AN ECLIPSE

Die Sonnenkorona

Von Prof. M. Waldmeier. Band 2: Struktur und Variationen der Monochromatischen Korona. (Lehrbücher und Monographien aus dem Gebiete der Exakten Wissenschaften. Astronomisch-Geophysikalische Reihe, Band 5.) Pp. 353. (Basel und Stuttgart: Birkhäuser Verlag, 1957.) 68.50 francs; 68.50 D.M.

SINCE the early 1930's a number of astronomers have followed Lyot in making regular daylight observations of the solar corona from suitable mountain-top observatories. Prominent among these has been Prof. M. Waldmeier, director of the Federal Observatory at Zurich, and to-day an acknowledged expert in this field. For nearly twenty years he has carried out an extensive programme of such measurements, working at his Observatory's mountain station above Arosa, and this is the second of a series of three books describing the results. The first two books are confined to little more than a description of the apparatus, the methods, and measures; the third will discuss the physics of the corona, presumably in a much more general way.

Since there is often misunderstanding among those without special knowledge of this subject, it may be well to emphasize that normal coronagraph observations, including Prof. Waldmeier's, do not go more than about 5 minutes of arc from the edge of the Sun's disk. Even with the most advanced electronic devices there is at present no possibility of measuring optically in broad daylight to more than a radius, say, 10–15 minutes of arc, from the solar limb. For everything beyond a few minutes of arc, out to the zodiacal light region, 25 deg. or so away, we must rely still on total solar eclipses and on radio astronomy.

This volume, then, relates to the inner corona only, but within this restricted region the amount of information provided is very considerable. Perhaps the most important feature of Prof. Waldmeier's work is that he has observed systematically, with as standardized a procedure as possible, over more than a whole sunspot period. This second volume concentrates on the brightness distribution within the corona in the light of a few bright spectrum lines, especially the green line, 5303A. of [Fe XIV], and the red line, 6374A. of [Fe X]. These lines are not only the most convenient to measure; their considerable difference in ionization-level means that the relative behaviour of the two gives us valuable information on temperature and electron-density variations.

Prof. Waldmeier provides us lavishly with tables and diagrams, so that we may follow easily the large changes in brightness and shape of the corona through the sunspot cycle, and may see also the close local relationship with sunspots and faculæ. A great deal of the work rests on simple intensity measurements at a given height in the corona, but in addition there are estimates of the greatest height to which the corona could be detected against the sky and a number of measures of isophotes in 5303A. light, made using the 5350A. line from a thallium lamp for comparison. A series of sketches of coronal condensations are also given. These are somewhat rarer phenomena, usually with a life-time not exceeding one hour, and are associated with large, active, sunspot groups, and with typical spot prominences.

Apart from the condensations, however, most of the coronal structure revealed in this work seems to be rather stable, with relatively small changes during intervals of a fortnight. It thus becomes possible, from what we see projected on the sky around the Sun, to construct a first approximation to the three-dimensional corona and to compare what we get with the activity on the photosphere beneath, although the spots, faculæ, etc., by which this activity is assessed are observed near the centre of the disk, separated by a week from the related measurements of the corona. The book gives many charts with comparisons of this kind.

This is very much an individual work. The measurements appear to have been made entirely by the author, single-handed. Literature references are to the author's papers exclusively, and little attempt has been made here to relate the observations to investigations by any other astronomer. Presumably a more general discussion and synthesis will come in the third volume. Meanwhile we have in this and the first volume an impressive collection of measurements, of great importance for anyone who wishes to become better acquainted with the still poorly understood outer atmosphere of the Sun.

R. O. REDMAN

LOW-TEMPERATURE PHYSICS

Handbuch der Physik

Herausgegeben von S. Flügge. Band 14: Kältephysik I. Pp. vi+349. 72 D.M. Band 15: Kältephysik II. Pp. vii+477. 112 D.M. (Berlin: Springer-Verlag, 1956.)

TO find, in an encyclopædia of physics running to fifty volumes, that two should be devoted specifically to low-temperature physics raises the question whether nowadays it is a sufficiently distinct branch to justify separate treatment. Perhaps before the War an affirmative answer could have been given; only a few laboratories were equipped to handle liquid helium, and they confined their attention almost exclusively to phenomena occurring at the lowest attainable temperatures. This attitude still persists in some laboratories, particularly the larger cryogenic laboratories in Europe, but it is beginning to seem a little out of date now that liquid helium is so readily available and its specialized techniques so easily assimilated. A more realistic taxonomy of physics is one which accepts solid-state physics as a major subdivision, comprising a wide variety of

topics such as metals, semi-conductors, dielectrics and magnetic materials, and perhaps incorporating the liquid state into honorary membership. In this classification cryogenics is relegated to a comparatively humble office as one out of many useful techniques, and this is surely as it should be. Electrical conduction at low temperatures is not, one hopes, to be sharply distinguished from electrical conduction at room temperature and upwards; and as our knowledge increases we may expect to see superconductivity (usually quoted as a typical low-temperature phenomenon) fit into place as but one aspect of the behaviour of metals. Similarly, although the interest of liquid helium essentially is derived from the fact that it remains liquid down to the lowest temperatures, its ultimate importance to physics does not so much lie in this as in the light it throws on the liquid state in general, and the fact that it provides both stimulus and critical tests for fundamental theories of the condensed state of matter.

Thus the editorial policy which has singled out low-temperature physics for special treatment has encouraged the authors to take a narrow view of their topics, and unfortunately several of them appear to have accepted this limitation of their scope with something like enthusiasm. Indeed, so much labour has obviously gone into these exhaustive compilations of facts that it may seem ungrateful to complain that the total effect is one of deplorable dullness. Yet there is indeed only one article, that by J. Bardeen on the theory of superconductivity, which can really be said to be exciting; and this is distinguished from the rest chiefly because the author is not content to act as an impassive recorder of what is known, but is eager to explore those regions where the meaning of the observations is obscure. It might perhaps be contended that speculation is out of place in this sort of ponderous compendium; but surely the reader may be permitted to expect a mite of imagination in return for the very stiff price he must pay. All too often we have in these articles the mere body without a breath of the quickening spirit, and £8 a volume is too much to ask for a sarcophagus of physics.

A. B. Pippard

NORTH AMERICAN SNAKES

Handbook of Snakes of the United States and Canada

By Prof. Albert Hazen Wright and Anna Allen Wright. Vol. 1: Pp. xviii+564. Vol. 2: Pp. ix+565–1105. (Handbooks of American Natural History.) (Ithaca, N.Y.: Comstock Publishing Associates (Division of Cornell University Press), 1957.) 14.75 dollars the two volumes.

HERPETOLOGISTS must form a very small percentage of the population, for the aversion and horror inspired by snakes in the ignorant is very widespread. "Because of his fear, his agricultural practices, his livestock, and his vehicles, man is the worst enemy of snakes. From senseless fear man kills beautiful small ringnecks and useful large rodent eaters with a wantonness hardly believable." But it will be a long time before he stops blindly following the biblical injunction to crush under the heel the allegorical satanic serpent. This exhaustive work gives an account of all the species of snakes found in the United States and Canada, and forms a valuable handbook for herpetologists everywhere but particularly for those of the North American continent. Gathering material for this book has occupied the authors for many years, during which they have examined, handled and photographed living examples of nearly all the species and subspecies, so that their descriptions are fully authoritative.

An introductory chapter of thirty-one pages explains the plan of the work, and discusses the various topics considered under each species. The authors point out that until recently the emphasis of herpetologists has been almost solely taxonomic, and that other aspects of the subject have been studied more or less incidentally, "for example, most of our life-history studies are of captive specimens in our zoos". The primary purpose of this book is to present the living animal, but "herpetology needs field studies of life-histories, food, movements, habits, general ecology, associations, and colour phases". The introduction includes maps showing the ranges of important plants, structural geology, forests and trees, the physical divisions of the continent, and the vegetation regions. These are most useful when used in conjunction with the numerous maps showing the range of individual species of snakes; "the types of rock masses together with the temperature and rainfall control the varied vegetative areas of the country and these in turn control the food and shelter on which the animal is dependent. We can to some extent associate certain species with distinctive soil and vegetative areas". Several pages deal with courtship and reproduction, and include an account of the varied and often bizarre surface anatomy of the hemipenis. Finally, the authors "urge young naturalists to keep journals", advice that cannot be too strongly emphasized. They note that both voluminous writers and "reticent superb field men, such as W. DeWitt Miller, have religiously recorded their observations", and rightly say that these notes prove "very useful, however good your memory may be". They might have added that even the best memory is unreliable for details, and that notes taken immediately are essential to any serious study.

The description of each species and subspecies is divided into sections: vernacular names, range, size, distinctive characters, colour, habitat, period of activity, breeding, food, field notes, and authorities. Each section is divided under various subheadings as information may be available. The nomenclature followed is mainly that of the second edition of Perkins' "Key to the Snakes of the United States" and of the sixth edition of Schmidt's "Check List of North American Reptiles". The illustrations are a special feature of the book—distribution maps, line drawings of anatomical details and scale patterns, and above all the photographs. The last show dorsal and ventral views of the whole animal, and larger views of the head and sections of the body, often in dorsal and ventral, as well as lateral, view, nearly always taken from the living snake.

The pagination of the work runs continuously through the two volumes, the second of which concludes with a glossary and a copious index. There is a select bibliography of general works on North American herpetology and of check lists. Although the work appears to be complete in two volumes the introduction to the select bibliography states that the complete bibliography will appear in Volume 3; this is the only reference to a future third volume.

DAMAGE TO SOLIDS BY LIQUID IMPACT AT SUPERSONIC SPEEDS

By Dr. F. P. BOWDEN, C.B.E., F.R.S., and J. H. BRUNTON
Physics and Chemistry of Solids Laboratory, Physics Department, Cambridge

A DROP of liquid striking against a solid surface at high velocity may produce considerable deformation and damage. Such damage can occur on the surfaces of aircraft during high-speed flight in rain; in this form it is referred to as 'rain erosion'[1]. Since 1945, when the problem of rain erosion first became apparent, its seriousness has increased enormously with increasing speeds of aircraft and missiles. Investigations into the mechanism of rain erosion have been carried out in the United States by Engel[2], and in Great Britain by Jenkins[3].

We are making a study in this Laboratory of some of the basic aspects of liquid/solid impact at very high speeds. For this purpose a simple apparatus has been developed for projecting a small cylinder of liquid against a stationary solid surface. The cylinder is normally about 1 mm. in diameter and 2 cm. in length, the mass of liquid involved being approximately equivalent to that of a large raindrop. Impact velocities of up to 3,500 ft./sec. have been obtained. Under such conditions even the hardest surfaces will become deformed.

Briefly, the apparatus consists of a small stainless steel injector into which about 0·01 c.c. of liquid can be sealed by a neoprene disk. At the instant of firing, a slug from a high-power air rifle rams the disk into the injector. The highly compressed liquid escapes through a nozzle at the far end of the injector as a short high-velocity jet or cylinder. Information on the structure, velocity and behaviour on impact of the liquid has been obtained by the Cranz–Schardin system of high-speed photography using a six-lens camera designed by Dr. J. S. Courtney-Pratt. In this manner it was possible to obtain six pictures of various stages in an event over a period of 25 μsec.

Fig. 1 is a picture of a water jet of 1 mm. diameter produced by the apparatus and moving in air. The nose velocity in this case is initially about 3,100 ft./sec. The structure of this jet can be regarded as typical of those produced by the apparatus. Air friction is responsible for the mushroom of spray at the nose of the jet; this type of break-up is quite small in the early stages of travel, but increases rapidly with distance. Because of this, target specimens are normally placed at a distance of ¼ in. from the nozzle. The cylindrical core of the jet maintains an approximately uniform cross-section along its length. High-speed photoelastic pictures indicate that only the core is responsible for inducing stress in the target material; the associated spray plays little part in the deformation process on impact. As a simplification then, the impact is considered to occur between a liquid cylinder and a plane specimen surface struck perpendicularly.

Deformation of Metals

An example of the type of deformation which can occur in a hard metal surface subjected to the impact of a water cylinder is given in Fig. 2*a*, together with the surface profile of the region in Fig. 2*b*. The metal in this case was a high-strength stainless steel. The main effect of the impact is to produce a shallow saucer-shaped depression in the surface, with the two additional features of a central pit, and a highly deformed annular region just inside the rim of the depression. The area of deformation corresponds closely to the area over which the spreading cylinder exerts a pressure; this is, of course, considerably greater than its initial cross-section. The pressure is assumed to be a maximum under the centre of the collapsing cylinder, and to fall smoothly to zero at points where the liquid flow first becomes entirely parallel to the surface. These positions can be determined from photographs taken during the impact. Such a pressure distribution on the surface would give rise to a depression similar to that in Fig. 2*b*. For comparison, the depression formed in aluminium under the same conditions is shown in Fig. 2*c*; the area of the surface affected is the same, but the depression is more than ten times as deep. The central pit in Fig. 2*a* and *b* is probably due to the effect of the very high pressure in this region on an already existing flaw or pit in the surface. Such a pit acts as a stress raiser favouring further localized deformation. In a soft metal this effect may be masked by the large overall flow.

The annular region of heavy deformation at the edge of the impact zone in metals has the appearance of having been sheared open by water flowing at very high speeds over it. The deformation marks consist of alternate ridges and depressions running parallel to the rim; in soft metals, flow channels are apparent in the depressions, indicating the manner in which metal has been sheared out to form the ridges. Such

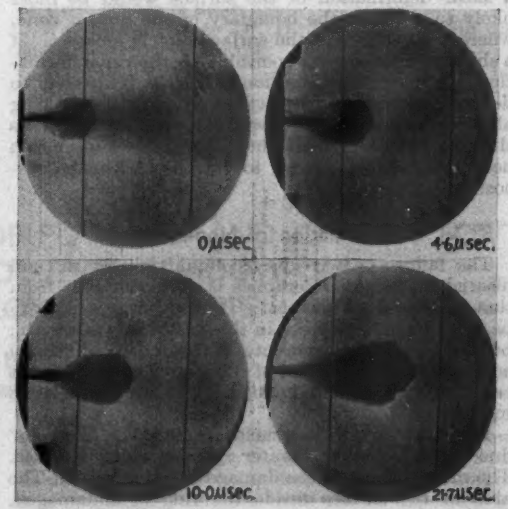

Fig. 1. A series of four frames selected from a group of six showing a water jet moving in air at an initial velocity of 3,100 ft./sec. The jet is travelling from left to right across two vertical marker wires 1 in. apart. The timing of each frame with respect to the first is shown in microseconds

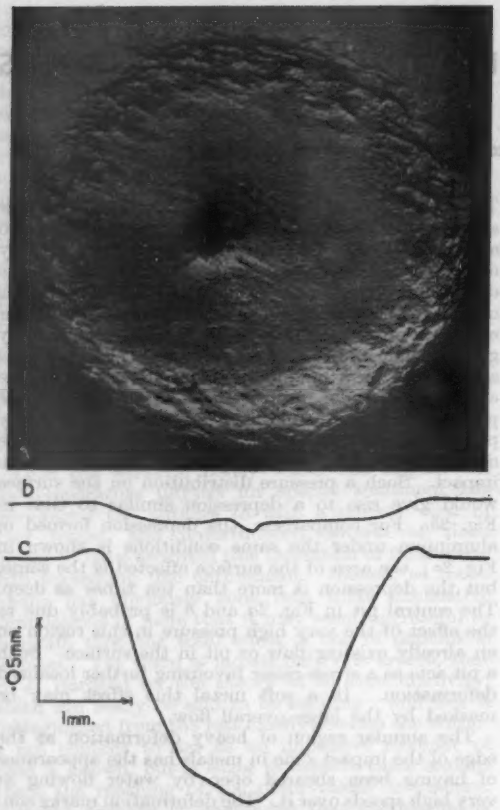

Fig. 2. (*a*) Deformation produced in a stainless steel surface by the impact of a single water jet at 2,500 ft./sec. The surface contour of the deformed region is given in (*b*), and for comparison the deformation of aluminium in (*c*)

a shear deformation of the surface would be most likely to occur at the boundary of the impact zone, where the velocity of the surface flow is greatest. If a shear mechanism is responsible for the rim deformation, then this deformation would be expected to depend upon the viscosity of the liquid. Using aluminium targets and water/glycerol mixtures as the deforming liquid, the intensity of the deformation near the rim was found to increase with the viscosity.

Deformation of Non-Metals

The failure pattern due to liquid impact in rigid plastics, glasses and ceramics is quite different from that observed in metals. 'Perspex' was found to be a convenient material in this group to work with; besides being transparent, it has the additional advantage that the state of stress in it during impact can be studied simultaneously by a photoelastic method.

Fig. 3 illustrates the surface damage in 'Perspex' due to the impact of a water cylinder at 3,000 ft./sec. The main feature of the damage is a ring crack. The area of the surface inside the ring is undamaged, and for a considerable distance outside the ring the surface is pitted with short straight circumferential cracks. The star crack which can be seen in the centre of the photograph is below the surface.

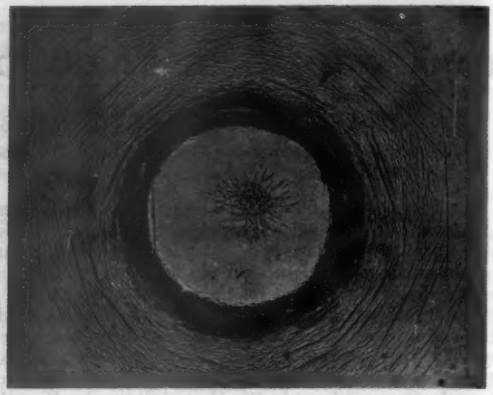

Fig. 3. Surface deformation in 'Perspex' due to the impact of a water jet at 3,000 ft./sec. The ring-crack has a mean diameter of 3·5 mm. The central star crack is beneath the surface

Fig. 4 is a cross-section through an impact zone in 'Perspex'. The central subsurface cracking consists of fracture planes lying approximately normal to the surface. The ring crack as seen in section meets the surface at an angle. Ring cracks produced at impact velocities of less than 2,000 ft./sec. often do not cut through to the surface. When this occurs, an annular depression remains in the surface above the crack; probably the presence of the crack facilitates permanent deformation of the area above it.

The effect of repeated impact on 'Perspex' is shown in Fig. 5. The surface profiles were obtained using a 'Talysurf' machine. The general behaviour is one of widening of the ring crack together with a spreading of subsurface cracks. After four or five impacts, the various fracture surfaces join up, and a large piece of 'Perspex' is dislodged from the surface.

As in the case of metals, failure in 'Perspex' can be thought of as arising primarily from the distribution of pressure under the jet, together with the deformation associated with rapid flow along the surface. Brittle failure may be expected to occur preferentially on planes across which the tensile stress is a maximum. The Hertz theory[4] of contact stresses can be used to predict the regions of high tensile stress in the 'Perspex' for the given distribution of pressure on the surface. Bearing in mind the limitations of the theory when applied to impact problems, it is possible to deduce that the maximum tensile stress occurs at the surface across the circular

Fig. 4. A cross-section taken through an impact zone similar to that shown in Fig. 3. The shape of the ring-crack and the central zone of subsurface cracking can be clearly seen

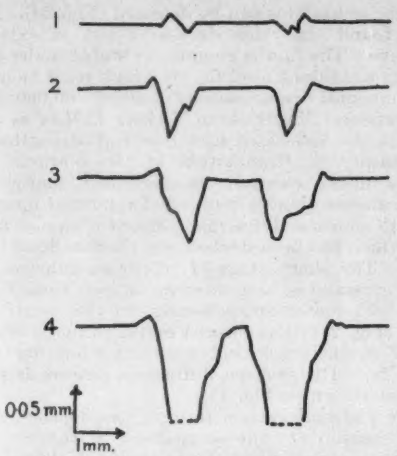

Fig. 5. The effect of 1, 2, 3 and 4 impacts of a water jet at 2,000 ft./sec. on the surface contours of 'Perspex'. The damage is seen to be concentrated in the ring-crack; the central region remains comparatively intact until massive breakdown occurs

boundary defining the limits of the area under pressure. Outside the boundary the tensile stress decreases slowly with distance; inside the boundary it falls abruptly to zero and becomes a compressive stress. Such a stress distribution accounts effectively for the pattern of surface cracking. The theory also predicts that the ring crack should form part of a conical rather than cylindrical surface.

Similarly, the tensile stress across the central axis normal to the surface attains a maximum value a little way below the surface; such a stress would explain the vertical planes of subsurface fracture in Fig. 4. The rapid surface flow accentuates these types of failure by opening up the fracture planes in the direction of flow, and in this way material is chipped from the surface.

Scabbing of the Back Surface

If the specimen is thin, a large scab may be detached from the back surface when the front surface is struck by the liquid. Fig. 6 shows this effect in a ¼-in. thick 'Perspex' plate. In this case, the top surface which has been struck has the normal ring crack, and the lower surface has developed a scab.

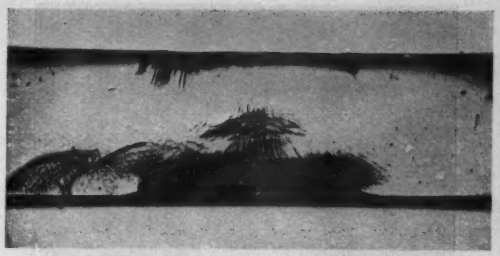

Fig. 6. Scabbing of the lower surface of a ¼-in. thick 'Perspex' plate. The velocity of the jet striking the upper surface was 3,000 ft./sec. The central zone of cracking in the body of the plate indicates a tendency to form a secondary scab, and illustrates the manner in which the reflected tension wave pulls the material apart

The compression wave set up on impact is reflected from the back surface as a wave of tension, and the associated tensile stress effectively pulls a piece out of this surface. The new surface so formed reflects the remainder of the compression wave, and the process of scab formation tends to be repeated. An attempt to form a secondary scab is shown by the cluster of cracks in the centre of the plate.

The fact that the impact of a water cylinder with a velocity of 3,000 ft./sec. can deform materials as hard, for example, as tungsten carbide is not surprising if it is realized that the pressure developed on the surface by the liquid is well above the yield strength of most common metals. The associated stress may be further magnified by the presence of surface pits. In addition, there are the shear stresses associated with the high-speed flow of the collapsed cylinder over the surface. Flow velocities parallel to the surface were observed to be two to three times as great as the impact velocity. Any surface irregularity in the path of this flow would certainly be deformed.

Since the present-day tendency is towards air travel at very high speeds, it is clear that an understanding of the mechanism of deformation processes at these speeds is desirable.

We are grateful to Dr. D. Tabor for helpful discussions during this work.

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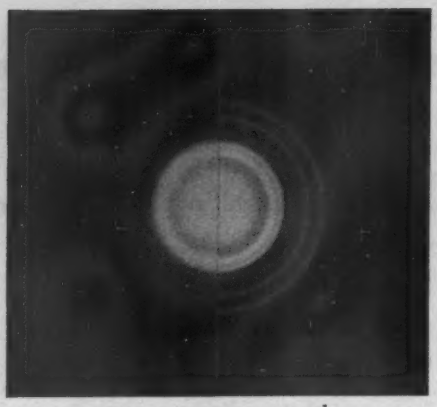
SIMULTANEOUS EVAPORATION OF PLATINUM AND CARBON FOR POSSIBLE USE IN HIGH-RESOLUTION SHADOW-CASTING FOR THE ELECTRON MICROSCOPE

By D. E. BRADLEY
Associated Electrical Industries, Ltd., Aldermaston

CONVENTIONAL methods for shadowing electron microscope specimens[1] have one grave disadvantage: the resolution obtained is seriously limited by the aggregation of the shadowing material into discrete crystallites. In the case of the much-used gold/palladium alloy, these particles may measure as much as 40–50 A. in diameter. Materials such as platinum and uranium, which are used where a higher resolution is required, form particles of about half this diameter. The resolution and quality of the resulting electron micrographs are limited accordingly. A few non-crystalline materials can be deposited by vacuum evaporation; among them are carbon[2] and silicon monoxide[3]. These materials produce sharp shadows, but their electron-scattering power is low, so that films of the order of 50 A. in thickness are



a *b*

Fig. 1. Electron diffraction patterns of a platinum/carbon film : *a*, under normal operating conditions ; *b*, recrystallized with very heavy electron bombardment (accelerating voltage 70 kV.)

required to obtain reasonable contrast. This thickness causes a loss in resolution due to 'pile-up' on the specimen[4], resulting in the distortion of its shape.

Clearly, a shadowing material of high atomic number, which does not form aggregates, is required. Aggregation must not occur either during deposition or under the influence of the electron beam. It has now been found that the simultaneous evaporation of a heavy metal and carbon produces a film with the required properties. Several metals have been tried, and the most suitable found so far is platinum.

The technique described here for achieving the simultaneous evaporation avoids the difficulties which would be encountered if two separate sources were employed. It is based on the method used for the evaporation of carbon alone[1]. Instead of pure carbon electrodes, however, rods containing a high percentage of platinum (about 85 per cent w/w) are used. These rods are prepared in the laboratory by an experimental process which involves bonding together the two constituents in powder form. The rods are pointed by means of emery paper and mounted in metal holders. A weak spring is fitted to hold the points together *in vacuo*. On passing a heavy current, resistance heating at the points causes carbon and platinum to evaporate together. The resulting film, even when thin, is strong enough to form a self-supporting replica. It can, of course, be deposited on previously prepared specimens in the normal way.

As deposited, the films are substantially non-crystalline. This can be seen from the halos of the electron diffraction pattern shown in Fig. 1*a*. When a dark-field image, selected from the brightest halo by means of the objective aperture, is examined, no discrete crystallites can be detected (Fig. 2*a*). It has been found that this dark-field test is extremely sensitive. The film is completely stable under illuminating conditions used for very high resolution work (instrumental magnifications of 40,000–60,000) in the experimental Metropolitan Vickers *E.M.6*, as developed in the Associated Electrical Industries Research Laboratory[5]. Granulation of the platinum only occurs under electron bombardment many times more intense than is required for normal operation. Fig. 1*b* shows a diffraction pattern obtained from a film which has been deliberately recrystallized in this way. The sharp rings of platinum indicate fairly large crystallites, and these are shown clearly under dark-field conditions, selecting the two bright inner rings (Fig. 2*b*). Evaporated platinum metal is shown under similar dark-field conditions for comparison (Fig. 2*c*). The electron diffraction pattern is similar to that shown in Fig. 1*b*.

The platinum/carbon ratio of the deposit has not been measured ; but comparison of the composite film with carbon films of equivalent thickness in the electron microscope indicates that the platinum content is high.

The preliminary examination of platinum/carbon shadowed surfaces in the electron microscope suggests that the method is extremely promising for high-resolution shadow-casting. Typical results are shown in Figs. 3 and 4. An important point, the production

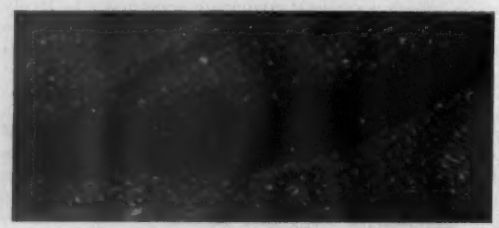


Fig. 3. Platinum/carbon replica (deposited at 45°) of an edge of a methyl orange crystal. (× 250,000)

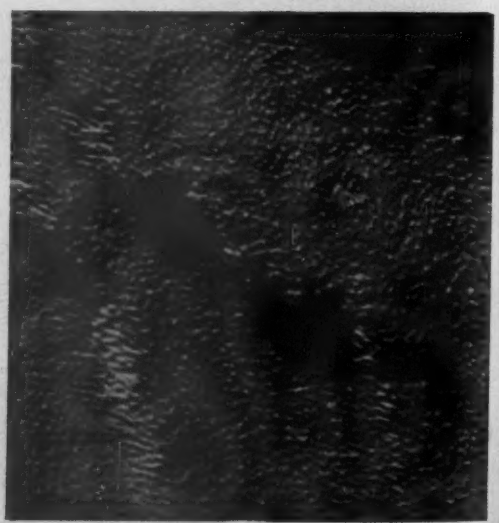
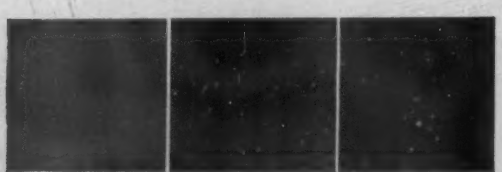


Fig. 4. Platinum/carbon replica (deposited at 45°) of a cleavage surface of a sugar crystal. (× 250,000)



a *b* *c*

Fig. 2. Dark-field electron micrographs (× 100,000) of : *a*, platinum/carbon film ; *b*, platinum/carbon film recrystallized as in Fig. 1*b* ; (*c*) evaporated platinum metal on a carbon film

of extremely sharp shadows, is illustrated in Fig. 3, which shows a platinum/carbon replica of an edge of a crystal of methyl orange. It is interesting to note that this shadow was obtained using a target distance of only 2·5 cm. (the distance for evaporated metal is 8–15 cm.), indicating a point source. It will be appreciated that there is a direct relationship between sharpness of shadows and resolution.

The potentialities of the method can be estimated from Fig. 4, which shows a platinum/carbon replica of the surface of a sugar crystal. It can be stated conclusively that the background structure is not due to the granulation of the shadowing material. The reasons are: (1) that the structure varies considerably over the surface; (2) that diffraction and dark-field tests, applied as a control to each specimen, indicate the total absence of any granularity. A close examination of the original plates shows that this structure consists of minute protrusions some 20 A. in width. This work will be published in greater detail elsewhere.

I wish to thank Dr. J. S. Halliday for his valuable advice, and also Dr. T. E. Allibone, director of the Research Laboratory, Associated Electrical Industries, Ltd., for permission to publish this article.

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PROCESSING OF FOODS WITH IONIZING RADIATIONS

MUCH attention has been aroused in recent years by the possibility of using ionizing radiations in preserving foods. Serious investigations started about ten years ago, although the idea itself is considerably older. While it has been found quite feasible to sterilize foods with radiation, some undesirable changes usually accompany the process. Such changes depend markedly on the way in which the food has been treated, and research has been particularly directed towards finding the precise conditions which give the best products. The possibilities and limitations of the method were discussed at a symposium held at Cambridge during September 26–27. About twenty foreign visitors were among the hundred and twenty who attended, and the two principal British laboratories working in this field—the Low Temperature Research Station, Cambridge, and the Technological Irradiation Group, Atomic Energy Research Establishment, Harwell—were represented.

The main attraction in using ionizing radiations to preserve foods is that the amount of radiation energy required to eliminate all food spoilage micro-organisms raises the temperature of the irradiated food by only a few degrees; the preservation of food in the raw state is therefore possible. A major deterrent, however, is that the associated chemical changes, though small in total quantity, may have adverse effects on the quality of the food, and become evident as changes in the odour, flavour or texture. It is necessary, therefore, to find methods to minimize or mask these quality changes. Smaller amounts of radiation which are insufficient to cause noticeable changes can be used. Such treatments eliminate only a fraction of the micro-organisms present—the so-called pasteurization treatments—and additional treatment, such as heat or refrigeration, is necessary to prevent spoilage of the food due to the growth of the surviving micro-organisms. Some of the results obtained using these techniques were described at the symposium. In addition to these generally applicable methods, there are also uses where small amounts of radiation can be applied to achieve a more limited particular purpose, for example, to eliminate insects in grain or packaged foods, or to inactivate food-poisoning *Salmonella* organisms in frozen whole egg; these applications, too, were discussed.

Much of the work on the irradiation of foods has been carried out in the United States, and British work is best considered against the background of American investigations. The Quartermaster Corps of the U.S. Army has sponsored the majority of this work and, not unnaturally, much emphasis has been placed upon military uses. The possibilities for civilian applications have, however, been kept clearly in mind. The present state of the work was outlined in two American papers, one by A. W. Harvey, and the other by D. K. Tressler, B. H. Morgan, M. Simon and V. K. Peterson. The dose of radiation necessary to achieve 'commercial' sterility in foods is considered to be in the range 3,000,000–6,000,000 rads. A large number of foods have been examined after doses of this magnitude, and twenty-one have been considered promising. Objectionable flavours are usually found to decrease on cooking, and generally the flavour of the irradiated foods tends to improve after storage for several weeks or months at room temperature. To support the vast amount of laboratory tests being conducted on irradiated foods, extensive animal feeding tests are in progress. These, so far, have not shown any harmful effects due to irradiation. Limited human feeding tests have also been made, again without showing adverse effects; and troop feeding tests on a larger scale are planned. To provide adequate food processing and radiation facilities for supplying the necessary food, the U.S. Army intends to construct a food-processing plant equipped with gamma-ray and cathode-ray sources, each of which can treat about 1,000 tons of food per month. Much basic research is being carried out by contract with civilian laboratories. In many cases, where the contractor is interested in civilian applications, the emphasis of this work is on the use of low-dose treatments. The smaller quality changes produced in this way will probably be more acceptable to the domestic consumer, who sees the food at all stages in its preparation for the table.

In Britain also, more attention has been given to pasteurization procedures, since most of the research has been aimed at civilian exploitation. R. S. Hannan described some of the results of a detailed examination of the response of chicken meat towards irradiation under a variety of conditions. With doses of 2,000,000 rads or more, flavour changes were considered objectionable by most members of a taste panel;

with lower doses the degree of flavour change depended markedly on the conditions before and during irradiation, for example, its oxygen content, and whether it was frozen. Odour changes in raw minced chicken meat could be detected with doses as low as 50,000 rads, but if such samples were afterwards cooked by steaming most people could only detect adverse flavour changes if the meat had been given doses of 250,000 rads. Whole chicken carcasses responded rather better: after doses of 500,000 rads or more, flavour changes were only just detectable in the roasted birds. Margaret J. Thornley said that bacterial counts on the minced chicken irradiated with 250,000 rads showed that it could be stored at 5° C. several times longer than unirradiated control samples; lower doses produced only a slight increase in storage life. Whole chicken carcasses, packed in 'Polythene' bags and given 500,000 rads, could be stored at 3° C. for two to three times as long as control samples. The bacterial flora of irradiated chicken differed considerably from that normally observed. M. Ingram emphasized that selective elimination of some micro-organisms by irradiation could result in the eventual spoilage of the chicken taking an unusual course. Adequate refrigeration seems essential to prevent the growth of possibly harmful bacteria which might survive irradiation.

A number of techniques have been suggested for minimizing the radiation damage to foodstuffs. Thus, for example, a low dose of irradiation combined with some heat treatment may be useful to sterilize foods. Freezing of samples before irradiation usually makes flavour changes less apparent, and the presence or absence of oxygen during and after irradiation is important. The use of such devices is being actively investigated. A very promising approach is to combine radiation with antibiotic treatment. This technique was used by J. Liston and J. M. Shewan in some experiments on the irradiation of fish. Cod and lemon sole suffered little adverse flavour change after doses of 500,000 rads, and the storage properties under refrigeration were improved. A much greater improvement in storage properties was achieved, however, when this dose of radiation was given after the fish had been dipped in a solution of chlortetracycline.

The use of radiation to eliminate a specific harmful micro-organism was discussed in a paper by R. S. Hannan, J. Brooks and Betty C. Hobbs on the irradiation of frozen whole egg. This commodity, large quantities of which are imported into Britain, often contains *Salmonella* bacteria which cause food-poisoning. 500,000 rads, given to the egg in the frozen state, eliminates the *Salmonella*. The principal adverse change was a slight odour in the thawed raw egg, which was not usually detected in baked products made from the egg.

Another promising application is the use of radiation to eliminate insect infestation. This is easily achieved by preventing reproduction of the insects with doses up to about 20,000 rads. Two methods of control exist: sterilization of all the insects or swamping of the female population by releasing a large excess of radiation-sterilized males. P. B. Cornwell described some experiments on the elimination of grain weevils and flour mill moths, using doses in the range 10,000–20,000 rads. Direct killing of these insects requires doses about ten times larger than this. If the economics of the process are favourable, there would appear to be little objection to the disinfestation of grain by this method. H. G. Harvey and R. S. Hannan had examined the effects of low doses of radiation upon packaged foods (for example, cereals, dried fruits, etc.) to eliminate insects, and found that in nearly all the foods examined, doses of 40,000 rads produced no detectable adverse changes.

The use of radiation in the food industry naturally presupposes that adequate sources of radiation will be available. Not all types of ionizing radiations are suitable. Any which might induce radioactivity in the food would be unacceptable—this excludes neutrons and radiations of energy higher than about 15 MeV. Others are excluded because of low penetrating power or high cost. The most generally useful are gamma-rays, of high penetration, and cathode rays, with rather limited powers of penetration. S. Jefferson, speaking on radioactive sources, said that large quantities of fission products will eventually be available for gamma-ray sources. For a number of years, however, cobalt-60, and smaller quantities of cæsium-137, are likely to remain the principal sources. At present the supplies of these are limited. M. C. Crowley-Milling, dealing with electrical machines as sources of radiation, said that cathode-rays of suitable energy are readily obtainable from linear accelerators now manufactured in Great Britain. Against the limited penetration of cathode-rays are the advantages of easy focusing, their availability as and when required, and the high dose-rates obtainable. The cost of treatment can be calculated, and Mr. Crowley-Milling gave the following estimates: to treat foods with 1,000,000 rads costs 0·4*d.* per lb.; to treat potatoes with 10,000 rads costs 1*s.* 6*d.* per ton; and to treat grain with 50,000 rads costs 5*s.* per ton. These figures make due allowance for running costs, depreciation, percentage of energy utilization, etc., but do not include any handling costs. The costs of treatment with gamma-rays are more difficult to calculate, but, for some time at least, are likely to be higher than those quoted above. Costs of this magnitude do not appear to be prohibitively high.

Other topics discussed at the symposium included the prevention of sprouting of potatoes (papers from W. G. Burton and D. B. Powell); and, among the less-promising applications, the sterilization of milk (T. Horne), the prevention of mould growth in wrapped baked products (F. J. H. Ottaway), and the elimination of micro-organisms in damp grain (T. A. Oxley).

The intensive investigations of the behaviour of food on irradiation have shown many gaps in the knowledge of how non-irradiated food behaves. This has led to the initiation of much fundamental research, both in academic studies and applied technology. As enzymes are not completely inactivated by the amounts of radiation necessary for sterilization, it is important to know what action surviving enzymes might have on stored foods. The paper by R. Zender, C. Lataste-Dorolle, R. A. Collet, P. Rowinski and R. F. Mouton, of the Battelle Memorial Institute, Geneva, was therefore interesting, dealing as it did with autolytic changes occurring during storage of sterile muscle samples. It may be that some of the changes observed with irradiated meats may be due to autolytic processes rather than to radiation effects. Similarly, much research in radiation chemistry and biology has been stimulated. At the symposium, three papers were presented on radiation chemical aspects (by A. J. Swallow, B. Coleby and N. Uri), and a further paper dealt

with some chemical effects in irradiated meat (G. M. Wilson). These contributions indicated that the theories of radiation chemistry are still far from adequate to explain the changes in such complex systems as foods. As R. S. Hannan pointed out, in nearly all cases, the easiest approach to a particular problem is an experimental one. In the microbiological field there is obviously need for more information on how micro-organisms behave on irradiation, and particularly on the behaviour of those organisms which survive irradiation. If, ultimately, the idea of processing food with radiation is not exploited, the results of such researches as that of the Quartermaster Corps of the U.S. Army on the properties of packaging materials will be of great value to the food industry.

It will still be necessary to show that irradiated foods are acceptable from the medical point of view, even if the process is considered useful to the food industry and the consumer. To yield information on this topic, animal feeding studies are being conducted at the Wantage Radiation Laboratory, and T. Horne gave details of these, and the plans for future work. The very careful and large-scale experiments being conducted by the Office of the Surgeon General of the U.S. Army should also be extremely valuable. To date, the tests have failed to show any harmful effects through eating irradiated foods. Some destruction of vitamins by irradiation has been noted but, in general, losses are no greater than with most other methods of food processing.

The symposium confirmed the impression that has been growing for some time, that radiation processing is unlikely to displace conventional methods of preservation. It does seem, however, that it will be a useful additional method, and there are clearly some applications of considerable potential use where it has special advantages. But, even with these, there still remains much more research to be done before the process can be exploited commercially.

A fuller account of this symposium is available on application to the Superintendent, Low Temperature Research Station, Downing Street, Cambridge (L.T.R.S. Memorandum 312).

This article has been prepared as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

B. Coleby

OBITUARIES

Prof. R. M. Davies

Rhisiart Morgan Davies, professor of physics in the University College of Wales, Aberystwyth, died suddenly on February 18, a fortnight after his fifty-fifth birthday.

His death terminates one of the most interesting careers in the British university world. He was a native of the quarrying village of Corris, Merionethshire, and received his early education at the village school and at the grammar school at Dolgelley, where his scientific potentialities were recognized by Dr. John Griffith, one of the most remarkable of Welsh headmasters. In 1921 he entered the College at Aberystwyth, where he was destined to spend virtually the whole of his university career. He graduated with first-class honours in 1924, and was appointed assistant lecturer in 1925.

His research career may be said to have commenced at the Admiralty Signal School at Portsmouth, where he spent the summer of 1925 and where he was introduced to quartz crystals and piezoelectricity. On his appointment to the staff at Aberystwyth he entered upon a research programme on the elastic properties of Rochelle salt crystals, as determined both statically and dynamically. The circuitry of this problem led him to digress, at the instigation of a chemical colleague, into a determination of the absolute dielectric constant of pure benzene at low radio-frequencies; he also developed two types of moisture meter for use with granular materials, one of which was marketed commercially.

These various research projects were pursued with characteristic vigour and determination, and gained him in succession the M.Sc. and D.Sc. degrees of his University. An opportunity to devote his whole time and energy to research, and in particular to his early field of interest, elasticity, came in 1939 with the award of a Leverhulme Research Fellowship, with which he proceeded to Cambridge to work with Sir Geoffrey Taylor.

Sir Geoffrey soon recognized in him not only one of the few academic physicists interested in the mechanical properties of materials, but also one who was, in addition, gifted with a penetrating mind, experimental skill of a high order, and an infinite capacity for hard work. The association of the two men, started in 1939, persisted through the years; it produced, during the war period, a wealth of results, embodied in official reports, which were of the greatest value in the war effort, both in attack and in defence, and it was later to inspire much of the work of the research school which Davies established at Aberystwyth, whither he returned in 1945 and where he was appointed professor in 1946.

The research work at Aberystwyth was concerned with transient stresses and the propagation of stress waves in solids, and with detonation pressures and shock waves in gases. Much of this work arose from Davies's investigation, carried out in Cambridge and published in the *Transactions of the Royal Society* in 1948, of the Hopkinson pressure bar, originally devised in 1914 and largely neglected. The resurrection of the pressure bar as a modern instrument of research into transient high-pressure phenomena was typical of Davies's flair for rediscovering near-forgotten techniques; he had read deeply in the classical researches of the past, and nothing gave him more pleasure than to revive, from some forgotten paper by Kelvin or Rayleigh or Reynolds, some argument relevant to a modern problem.

The nature of this extensive research programme, of a type rare in British universities, inevitably brought to Aberystwyth many visitors from many lands, and to Davies himself many invitations to address conferences and symposia, and to join technical committees of various Ministries. In this way he very greatly enlarged his field of activity and became widely known as one of the leading authorities in his particular subject.

In 1956 he was invited to accept a visiting professorship at the California Institute of Technology

at Pasadena. During seven months in the United States, he visited many American universities and research institutes and delivered numerous discourses; in quite characteristic fashion, he scorned American public transport, and drove his own car, acquired in New York on his arrival and disposed of there on his departure, across the American continent, over a total distance of 16,000 miles. Shortly after his return, Davies was again invited to visit the United States, to address the annual meeting of the American Institute of Mining and Metallurgical Engineers, held in New York in February this year; he had agreed to do so, and to visit other centres to renew contacts made during the previous year, but he died during the week of the meeting.

Research, though energetically and enthusiastically pursued, by no means represented the sum total of his activity. He was a teacher of unusual quality, and his lectures were invariably prepared with meticulous care and presented with superb lucidity. He was, in addition, a gifted administrator; his department was most efficiently organized, and he was, for a period, vice-principal of his College. He had also numerous other interests quite unconnected with his academic work. He was an accomplished musician with a particular interest in church music, and was organist and choirmaster in his own church at Aberystwyth and at the church which he attended at Cambridge; he had in his early years been an active cross-country runner and retained throughout a lively interest in all kinds of sport, his last hobby being yachting; and in his rare moments of relaxation, he was an avid reader of detective fiction.

In all the many facets of his life, he had an essential good-nature and personal charm which brought him a host of friends, varying immensely among themselves, but united by their regard for his warm humanity and patent sincerity. The key to his character undoubtedly lay in the fact that his roots remained firmly fixed in his native Welsh soil, and he carried into the wide world the virtues implanted in him by the devout, unhurried and unpretentious atmosphere of his upbringing. I. C. Jones

The sad news of Prof. R. M. Davies's sudden death came as a shock to his many friends in the United States. He had been invited to lecture at the American Institute of Mining and Metallurgical Engineers Symposium on High-Speed Stressing of Solids in New York City on February 17. It was with great disappointment that we heard that, due to illness, it was necessary for him to cancel that visit.

He had been in the United States twice, once during the Second World War and again for the academic year 1956–57, when he was a visiting professor and lectured at the California Institute of Technology and at Rensselaer Polytechnic Institute. During this last visit, in addition, in his travel from coast to coast, he gave lectures at various universities and technical institutes.

Prof. Davies was a superb teacher, and all those who had the fortune to attend his lectures will never forget the excellence and brilliance of his presentation. As a result of his research, especially in the field of stress waves in solids, he leaves important and permanent contributions.

Those who knew R. M. Davies during the Second World War, when he was working under Sir Geoffrey Taylor at Cambridge for the Ministry of Supply, will always remember the very happy combination of 'G. I.' and 'R. M.'. His loss is particularly felt by the many who enjoyed his friendship and appreciated his warm personality, his deep Welsh sense of humour and the interest, helpfulness and understanding he always showed toward other people. These friends will realize that with the passing of R. M. Davies a very dear part of their lives has forever ended.

Enrico Volterra

Prof. T. Shimizu

Tayei Shimizu, who died suddenly on January 30, was well known as the founder of the chief Japanese school of studies on steroids and especially bile acids. He was a pupil of the late Heinrich Wieland from 1920 until 1923, and again from 1929 until 1931, and from him returned to Japan with an enthusiasm in this field which proved lifelong.

Shimizu was born in Tokyo in 1889 and graduated from Kyoto University Medical School in 1915. He began his studies on bile acids there, under the late Prof. T. Araki. After his return from Germany in 1923, Shimizu was appointed professor of biochemistry at Okayama Medical School: he became president of this School in 1949 and, in 1952, president of Okayama University. He was elected a member of the Japan Academy in 1950, and in 1951 a member of the German Academy of Sciences.

Much of Shimizu's scientific contribution consisted in the persistence and skill with which he and his pupils followed up the observation of Hammarsten (1898), who found the steroid alcohol, scymnol, in the bile of sharks. This ought, perhaps, to have stimulated a much wider search for unusual bile salts, but it was not until Shimizu began his work that such a search was seriously undertaken. It was then pursued with remarkable zeal: for example, 4,000 toads were used to collect 5 litres of bile; from this were obtained interesting alcohols, finally carefully described by T. Kazuno (*Hoppe-Seylers Z.*, **266**, 11; 1940) and the bile acids trihydroxysterocholenic and trihydroxy-*iso*sterocholenic, $C_{22}H_{46}O_5$, characterized by Shimizu and T. Oda (*Hoppe-Seylers Z.*, **227**, 74; 1934), and by Shimizu and T. Kazuno (*Hoppe-Seylers Z.*, **239**, 67; 1936). In later work, Y. Okasaki (*J. Biochem. Tokyo*, **36**, 65, 77; 1944) collected 1·5 litres of bile from 100,200 specimens of a newt, *Diemyctylus phyrrhogaster*. An account of the work of Shimizu's school up to 1935 was included by him in a comprehensive book ("Über die Chemie und Physiologie der Gallensäuren", Muramato, Okayama, 1935), which he dedicated to Prof. Araki on his seventieth birthday. K. Ohta (*Hoppe-Seylers Z.*, **259**, 53; 1939) reviewed the work at Okayama on fish bile, and later writers have summarized the Japanese contributions up to 1955 (for example, *Physiol. Rev.*, **35**, 178; 1955).

The discoveries of Shimizu and his pupils have widened greatly the scope of chemical and physiological study of bile salts, and have stimulated a new awareness of the interest of biochemical species comparisons in this as in other fields.

In June 1957 Shimizu paid his last visit to Wieland, and also visited England for the first time for nearly forty years. He then, in spite of an indifferent command of English, read a paper on some of the work now being done by one of his former pupils, S. Hayakawa. He spent some time in the United States before returning to Japan.

Tayei Shimizu was a man of broad vision, good humour and modesty of character. His memory is held in affection by his friends and former pupils everywhere. G. A. D. Haslewood

NEW FELLOWS OF THE ROYAL SOCIETY

AT a meeting of the Royal Society on March 20, the following were elected to fellowships:

MICHAEL ABERCROMBIE, reader in embryology in the University of London at University College, distinguished for his researches in embryology, tissue culture, and wound healing.

DR. E. P. ABRAHAM, senior research officer at the Sir William Dunn School of Pathology, University of Oxford, distinguished for his work on the isolation and chemistry of antibacterial substances.

DR. J. R. BAKER, reader in cytology in the University of Oxford, distinguished for his researches on the chemistry of the cell.

PROF. J. A. BIRCH, professor of organic chemistry in the Victoria University of Manchester, distinguished for his studies on the structure and biogenesis of natural products.

PROF. SATYENDRANATH BOSE, vice-chancellor of the Visva-Bharati University, Santiniketan, India, distinguished as the discoverer of Bose-Einstein statistics.

DR. P. W. BRIAN, head of the Department of Microbiology, Akers Research Laboratories, Imperial Chemical Industries, Ltd., distinguished for his researches on microbiology and plant pathology.

EDITH BÜLBRING, demonstrator in pharmacology in the University of Oxford, distinguished for her work on smooth muscle and on the action of adrenaline.

DR. R. K. CALLOW, research chemist at the National Institute for Medical Research, London, distinguished for his work on steroid chemistry.

DR. F. DIXEY, director of Overseas Geological Surveys, London, distinguished for African geological researches, particularly in tectonics, geomorphology and ground-water hydrology.

PROF. P. P. EWALD, head of the Department of physics in the Polytechnic Institute of Brooklyn, distinguished for his outstanding contributions to the science of X-ray optics.

PROF. F. J. FENNER, professor of microbiology in the Australian National University, Canberra, distinguished for his work on microbiology, particularly the pathogenesis and epidemiology of mousepox and myxomatosis.

DR. W. H. GLANVILLE, director of the Road Research Laboratory, Department of Scientific and Industrial Research, Harmondsworth, distinguished for his researches on reinforced concrete and on road construction.

PROF. A. E. GREEN, professor of applied mathematics in the University of Durham (King's College, Newcastle upon Tyne), distinguished for important contributions to the mathematical theory of elasticity and hydrodynamics.

PROF. A. HADDOW, professor of experimental pathology in the University of London and director of the Chester Beatty Research Institute (Institute of Cancer Research, Royal Cancer Hospital), distinguished for his investigations into the chemotherapy of malignant disease.

DR. G. HIGMAN, reader in mathematics in the University of Oxford, distinguished for his contributions to the theory of groups.

PROF. A. ST. G. J. MCC. HUGGETT, professor of physiology in the University of London at St. Mary's Hospital Medical School, distinguished for his investigations on the physiology of reproduction and on the transfer of materials from mother to fœtus.

PROF. H. C. LONGUET-HIGGINS, John Humphrey Plummer professor of theoretical chemistry in the University of Cambridge, distinguished for his application of mathematics to problems in physical chemistry.

PROF. B. LYTHGOE, professor of organic chemistry in the University of Leeds, distinguished for his contributions to the chemistry of natural products.

PROF. S. K. MITRA, professor of physics and director of the Institute of Radio-Physics and Electronics, University of Calcutta, distinguished for his researches in many branches of upper atmosphere physics.

DR. C. H. MORTIMER, secretary of the Scottish Marine Biological Association and director of the Marine Laboratory, Millport, distinguished for his research upon lakes and lake-deposits, and the chemical and physical conditions which control life in them.

PROF. R. S. NYHOLM, professor of chemistry in the University of London at University College, distinguished for his contributions to inorganic chemistry, especially for his studies of complex compounds of the transition elements.

PROF. G. D. ROCHESTER, professor of physics in the University of Durham (Durham Colleges), distinguished for his researches on the cosmic radiation, and particularly for his contributions to knowledge of the unstable elementary particles.

PROF. O. A. SAUNDERS, dean of the City and Guilds College and head of the Department of Mechanical Engineering in the Imperial College of Science and Technology, University of London, distinguished for his contributions to the study of heat transfer and to the development of the internal combustion engine.

PROF. J. E. SMITH, professor of zoology in the University of London at Queen Mary College, distinguished for his researches on the principles of nervous organization as exemplified by lower animals.

DR. W. B. TURRILL, formerly keeper of the herbarium and library at the Royal Botanic Gardens, Kew, distinguished for his experimental and descriptive work on flowering plants of Britain and the Near East.

NEWS and VIEWS

Animal Physiology at Cambridge : Dr. Ivan de Burgh Daly, F.R.S.

Ivan de Burgh Daly, who is retiring from directorship of the Agricultural Research Council Institute of Animal Physiology, Babraham, studied medicine in Cambridge and at St. Bartholomew's Hospital and qualified as a physician in 1918 after serving in the R.N.A.S. He worked as a Beit Memorial Research Fellow at University College, London. He was professor of physiology in Birmingham (1927–32) and Edinburgh (1933–47), before going to Babraham as the first director of the Agricultural Research Council's Institute of Animal Physiology in 1948. In Starling's department he became interested in the physiology of the circulation and his skill as an engineer enabled him to construct elaborate apparatus for perfusing blood through isolated organs from dogs and recording the effects of drugs and of nervous stimulation on the distribution of blood and the resistance to flow. He is especially interested in the complex circulation in the lungs and is the leading authority on this subject.

During the past ten years he has been mainly responsible for the formation of the Institute at Babraham, with a distinguished staff of more than thirty scientists and ideal facilities for work on the physiology of larger animals than those normally studied in the physiological departments of medical schools. Under his leadership the Institute has grown rapidly and continues to grow. Scientists with wide experience in physiology, biochemistry and pathology have joined forces and are doing fundamental work on sheep, cows and pigs. His wisdom in resisting demands for the quick solution of problems of immediate practical importance is becoming more apparent as time goes by.

Prof. J. H. Gaddum, F.R.S.

John Henry Gaddum, who is to succeed Dr. I. de B. Daly as director of the Institute of Animal Physiology, qualified in medicine at Cambridge and University College Hospital. In 1925 he went to the Wellcome Physiological Research Laboratories at Beckenham, where he worked with the late Dr. J. W. Trevan, and left in 1927 to join Sir Henry Dale at the Medical Research Council Laboratories. At Hampstead he worked on the liberation of acetylcholine-like substances and established in collaboration with W. Feldberg that the nerve impulse in the superior cervical ganglion is transmitted by acetylcholine. He also developed methods for the bioassay of thyroid hormone and became interested in the interpretation of quantal bioassays; this was a matter of some difficulty as the log dose–percentage mortality curve was sigmoid in shape. He introduced the idea of plotting the normal equivalent deviation against the logarithm of the dose used, thus obtaining a straight line. To avoid the use of a negative quantity it was later suggested that the normal equivalent deviation + 5 should be called the 'probit' and this probit figure should be plotted against the log dose. Gaddum's pioneer work in this subject was published in a Medical Research Council report in 1933. After occupying chairs at Cairo and University College, London, in 1942 he was appointed to the chair of materia medica in the University of Edinburgh in succession to the late Prof. A. J. Clark, where he has added great distinction to the Department during the past sixteen years.

Gaddum has been interested in a wide field of pharmacological experiment, particularly in respect of the pharmacologically active substances obtained from tissue extracts. He has done a great deal to elucidate the substances liberated when autonomic nerves are stimulated. This work started with acetylcholine and noradrenaline, and he has continued it with 5-hydroxytryptamine and substance *P*. He has been interested in the antagonism of 5-hydroxytryptamine by lysergic acid diethylamide, and recently he has edited a monograph on polypeptides which stimulate plain muscle. He has been responsible for the statistical analysis of many bioassay procedures, and has written the appendix to "The British Pharmacopœia" on the mathematical basis of bioassay; he has also written a very popular text-book of pharmacology, now in its fourth edition. He has been a member of the Committee of the Medical Research Council from 1948–51 and a Fellow of the Royal Society since 1945. His appointment as director of the Agricultural Research Council's laboratories at Cambridge will give a great stimulus to the study of pharmacology in connexion with agricultural problems.

Materia Medica at Edinburgh : Dr. W. L. M. Perry

The appointment is announced of Dr. W. L. M. Perry to the chair of materia medica in the University of Edinburgh in succession to Prof. J. H. Gaddum, who is leaving Edinburgh to become director of the Agricultural Research Council Institute of Animal Physiology at Babraham. Dr. Perry, who graduated in medicine at St. Andrews in 1943, joined the scientific staff of the Medical Research Council at the National Institute for Medical Research in 1947, having completed a tour of duty in the Colonial Medical Service in West Africa. In his first research, Dr. Perry collaborated with Dr. F. Hawking in work which revealed the indirect mode of chemotherapeutic action of proguanil. Thereafter, he turned to subjects on the borderline between physiology and pharmacology, publishing a number of papers on transmission in the autonomic nervous system, and at the same time developing an interest in the principles and technique of biological assay, to which subject he made notable contributions. In 1951, Dr. Perry was appointed director of the Division of Biological Standards at the National Institute for Medical Research; in this position he has carried with apparent ease a burden of work and responsibility which, especially during the past two years, has been unexpectedly heavy because of the involvement of the Division in the safety testing of poliomyelitis vaccine. Dr. Perry thus goes to Edinburgh having behind him an unusual breadth of scientific and administrative experience; with the return to laboratory research that his new post will permit, it can be confidently anticipated that he will not only uphold but also add to the distinguished traditions of the chair of materia medica in Edinburgh.

Viking Fund Medals for 1957

The 1957 Viking Fund Medals and prizes of 1,000 dollars each for outstanding contributions to anthropology have been awarded to Drs. Raymond A. Dart, James B. Griffin and Margaret Mead. Dr. Dart was elected by the American Association of Physical Anthropologists as medallist in physical anthropology. He is dean of the Faculty of Medicine at the University

of the Witwatersrand. Since 1925, Dr. Dart has discovered many specimens of a sub-human creature, *Australopithecus prometheus*. He postulated that this proto-man belonged to the hominid rather than the ape family, and that Africa, not Asia, was the birthplace of man. In 1955, Dr. Dart discovered *Australopithecus* buried with crudely-worked tools of a Pebble Culture. Dart's theory was thereby accredited and his find recognized as the most primitive creature known to date that can be called human. Dr. Griffin, director of the Museum of Anthropology and professor of anthropology at the University of Michigan, was cited by the Society for American Archæology for his great influence in promoting the aims of scientific archæology, and for his unsurpassed knowledge of the form, range and distribution of artefact styles in North America. Dr. Mead was selected as the 1957 medallist in general anthropology by the American Anthropological Association. She is associate curator of ethnology at the American Museum of Natural History, and has done more than any other single individual to introduce anthropology to the American public. A prolific writer, among Dr. Mead's most popular books are "Coming of Age in Samoa", "Growing Up in New Guinea", "Male and Female" and "New Lives for Old".

The Viking Fund Medals and awards originated upon the suggestion of Dr. Axel L. Wenner-Gren, the Swedish industrialist who endowed the Foundation now bearing his name. Since 1946, the Wenner-Gren Foundation has provided the medals and prizes of 1,000 dollars, which are awarded to the general anthropologist, archæologist and physical anthropologist who has made a significant contribution to his field.

Train Control on Railways in Britain

In replying to a debate on automatic train control on March 7, on an adjournment motion moved by Mr. P. C. Goodhart, Mr. G. R. H. Nugent, Parliamentary Secretary to the Ministry of Transport and Civil Aviation, said that in the past 46 years, 698 formal inquiries had been made in Britain into rail accidents in which 1,599 people were killed. Of these accidents, automatic train control could probably have avoided 11 per cent and 31 per cent of the fatalities. Track circuiting is a further safety device which serves primarily to record that a train is in a particular sector of the track, and with colour light signals, which are easier to see, especially at night and in fog, and can be linked with automatic train control and track circuits and the control board in the signal box, could make a big contribution to traffic safety but without eliminating the human element. Automatic train control was started on the initiative of the Great Western Railway in 1905, but the equipment of the main lines of Britain was not completed until 1930, and the non-contact magnetic Hudd system evolved in the 1930's and tried on the London, Midland and Scottish Railway was not finally approved by the Minister of Transport until 1947. In 1948, the British Transport Commission decided to make a wide extension of automatic train control, colour light signals and track circuits: the Great Western system was regarded as unsuitable for electric lines and its heavy mechanized parts were unsuitable for permanent and universal adoption. The Commission is also convinced that a non-contact magnetic system superior to the Hudd system could be found; but although full-scale trials have been carried out since 1950 on the east coast line, as was expected, many difficulties were encountered. The routes carrying the greatest train frequency and speed would receive the earliest attention, and installation is in no way retarded by capital restrictions.

Millenary Celebrations of Al-Mas'udi

The millenary of Al-Mas'udi, the tenth century Arab geographer, traveller and encyclopædist, was recently celebrated at the Muslim University, Aligarh, under the joint auspices of the Institute of Islamic Studies, Aligarh, and the Indian Society for the History of Science. About thirty papers were received from all parts of the world, including Britain, Egypt, France, Holland, India, Iran, Lebanon and the United States

Mr. A. A. A. Fyzee, vice-chancellor of the University of Jammu and Kashmir, devoted his presidential address to the need for studies of the humanities in the university, particularly in view of the technological changes in progress in India. He stressed that the aim was not to produce theologians, which has been the dominant tendency in the past, "but to produce men of understanding and intelligence, of balanced judgment and critical appreciation of the past". Prof. M. S. Thacker emphasized the collaboration that had existed between the Arab countries and India in the search for knowledge. After giving a general survey of Al-Mas'udi's contribution in the field of science, he suggested the great need for a scientific study of the available material, particularly from the point of technology and its relation with the intellectual attainments of the age. Prof. N. Ziadeh discussed the geographical, climatological and certain social details of Sham (Syria) given by Al-Mas'udi, and Dr. M. Shafi dealt with his geographical contributions, particularly in the field of human geography, which Al-Mas'udi did much to establish on scientific lines. In a general survey of science at the time of Al-Mas'udi, Mr. A. Rahman emphasized its characteristic features, namely, its association with the concept of God as the driving force of the universe, and its relation to the Greek philosophical outlook. It is proposed that the contributions shall be published in the form of a commemorative volume.

Society for Visiting Scientists

The report of the secretaries on behalf of the Council of the Society for Visiting Scientists to the tenth general meeting on December 19 records continued restriction, for financial reasons, of the Society's activities, although the Overseas Science Students' Association continues to flourish. The Society has now nearly 2,900 members, from sixty-five countries, but only one reception could be held during the year, for participants in the symposium of the Royal Astronomical Society and the Royal Meteorological Society on "Planetary Atmospheres and Convection in Rotating Fluids". The Society's information service is constantly growing, helped by generous gifts of periodicals and reference books, but only limited success attended an attempt to increase the income from industry. Five most successful discussion meetings were held during the year, dealing respectively with "The Effects of Low Temperatures on Mammals and their Tissues"; "The Widening Field of Application of Electronic Computers"; "Taste and Smell"; "Water Quality Problems in the United Kingdom"; and "Science and Furniture". The lively discussion which characterized all the Society's meetings is further indication of the value of its

work and of the desirability that adequate financial support should enable it to make its full contribution in assisting scientific co-operation and understanding.

The Parapsychological Association

The formation of the Parapsychological Association, an international professional group of research workers in the field of extrasensory perception and psychokinesis, has been announced. The objects of the Association are to advance parapsychology as a science, to disseminate knowledge of the field, and to integrate the findings with those of other branches of science. Full membership is restricted to those with doctorate degree training or equivalent. The founding officers are: *President*, R. A. McConnell (Biophysics Department, University of Pittsburgh); *Vice-President*, G. R. Schmeidler (Psychology Department, City College of New York); *Secretary*, R. White (Parapsychology Laboratory, Duke University); *Treasurer*, R. J. Cadoret (Duke University); *Members of Council*, M. Anderson (Duke University), K. Osis (Parapsychology Foundation of New York) and W. G. Roll (University of Oxford).

Conference on High Energy Nuclear Physics

More than 200 scientists from twenty-six nations have been invited to participate in the 1958 Annual International Conference on High Energy Physics, organized by the European Organization for Nuclear Research (CERN), in Geneva during June 30–July 5. Participation at the 1958 Conference is by invitation only. Among the 226 scientists invited so far, more than a hundred have already accepted, among them: Prof. W. Heisenberg, of Germany; Prof. Leprince-Ringuet, of France; Prof. E. Amaldi, of Italy; Prof. Hideki Yukawa, of Japan; Prof. P. Scherrer and Prof. W. Pauli, of Switzerland; Sir John Cockcroft and Prof. P. M. S. Blackett, of the United Kingdom; and from the United States, Dr. C. N. Yang, Dr. T. D. Lee, Dr. J. R. Oppenheimer and Prof. L. W. Alvarez. During ten plenary sessions in the auditorium of the Physics Institute of the University of Geneva, papers will be presented on nucleon structure; the nucleon and its interactions with pions, photons, nucleons and anti-nucleons; fundamental theoretical ideas; strange particle production and interaction; invariance principles and selection rules, and weak interactions. The conference proceedings, including original papers presented, will be published by CERN.

Second Geneva Conference on Peaceful Uses of Atomic Energy

The second International Conference on the Peaceful Uses of Atomic Energy is to be held in Geneva during September 1–13, under the auspices of the United Nations (*Nature*, 180, 217; 1957). The president of the Conference is to be Prof. F. Perrin, of the Commissariat à l'Energie Atomique de France, and the secretary-general, Dr. S. Eklund, of Sweden. Two atomic energy exhibitions will be held in Geneva during the Conference. The first will be a scientific exhibition under the auspices of the United Nations, at the Palais des Nations. A United Kingdom exhibit, 5,000 sq. ft. in extent, is being arranged by the U.K. Atomic Energy Authority, to include a model of the thermonuclear research apparatus, ZETA. The other exhibition, which will be commercial, is the International Exhibition on the Peaceful Uses of Atomic Energy, at the Palais des Expositions. The British section is being organized by the Nuclear Energy Trade Associations' Conference, which represents all major British firms concerned with atomic energy. People interested in attending the Conference as observers should apply for passes not later than April 19. Representatives from industrial firms who are working in the atomic energy field should apply to Mr. M. H. L. Whitehouse, Nuclear Energy Trade Associations' Conference, 32 Victoria Street, London, S.W.1, and all others to Mr. J. C. Walker, United Kingdom Atomic Energy Authority, 11 Charles II Street, London, S.W.1. The United Kingdom representatives on the United Nations scientific secretariat for the Conference will be Mr. F. Hudswell and Mr. W. B. Woollen (Atomic Energy Research Establishment, Harwell) and Mr. T. E. F. Carr (Medical Research Council).

Isotope Courses at Harwell

A course on radioisotopes, designed to give senior executives in industry an appreciation of the possible applications of those materials, will be held at the Harwell Isotope School during September 23–26. Two similar courses have been arranged for April 15–18 and July 8–11 for members of the Institute of Directors only. The course consists of lectures on the elementary principles of work with radioactive isotopes with the emphasis on their application as tools in industry and research. The lectures will be given in as non-technical a manner as possible by scientists experienced in the field; they will be supplemented by visits to a reactor and to the laboratories of the Isotope Division at Harwell and at the Wantage Radiation Laboratory near Harwell. The lectures and demonstrations will be given in the Cockcroft Hall at Harwell. Further information can be obtained from the Registrar, Isotope School, Atomic Energy Research Establishment, Harwell.

City and Guilds of London Institute: Fellowships

The Council of the City and Guilds of London Institute have conferred the Fellowship of the Institute (F.C.G.I.) upon the following past students of the City and Guilds College or Finsbury Technical College in recognition of their distinguished contributions to industry or the professions in which they are engaged: D. H. Alexander, principal, College of Technology, Belfast; W. A. Coates, retired, former director of Metropolitan-Vickers Electrical Co., Ltd.; G. H. Hopewell, managing director, Foster Wheeler, Ltd.; F. C. Wright, managing director, Standard Telephones and Cables, Ltd.

The Night Sky in April

Full moon occurs on April 4d. 03h. 45m. U.T., and new moon on April 10d. 03h. 23m. The following conjunctions with the Moon take place: April 5d. 04h., Jupiter 2° N.; April 9d. 02h., Saturn 3° S.; April 13d. 13h., Mars 7° S.; April 15d. 00h., Venus 4° S. There will be an annular eclipse of the Sun on April 19, invisible at Greenwich. Mercury is favourably placed for observation during the first week of the month, setting at 20h. 20m. on April 1; its stellar magnitude on that date is + 0·5. Later in the month, Mercury is too close to the Sun for observation. Venus is a morning star, visible low in the south-east before sunrise. It rises at 4h. 10m., 3h. 50m. and 3h. 25m. on April 1, 15 and 30, respectively; its stellar magnitude is about − 4·0. During

the month its distance from the Earth increases from 58 to 80 million miles and the visible portion of the apparent disk from 0·450 to 0·600. Mars rises at 4h. 00m., 3h. 30m. and 2h. 50m. at the beginning, middle and end of the month, respectively. It is visible low in the south-east before sunrise, but conditions are not very favourable; its stellar magnitude is + 1·0. Jupiter rises at 20h. 05m., 19h. 00m. and 17h. 45m. on April 1, 15 and 30, respectively, and sets at 4h. 20m. on April 30; it is visible throughout the night. Opposition is on April 17; the planet is near Spica. The stellar magnitude of Jupiter is − 2·0, its distance from the Earth on April 15 being 410 million miles. Saturn rises at 1h. 05m., 0h. 10m. and 23h. 10m. at the beginning, middle and end of the month, respectively; it is east of θ Ophiuchi. Its stellar magnitude is + 0·6 and it is at a distance of 890 million miles from the Earth on April 15. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: April 6d. 04h. 20·5m., α Lib. (*D*); April 25d. 20h. 34·9m., 68 Gem. (*D*). *D* refers to disappearance. The Lyrid meteors are active during April 20–22. Conditions are very favourable; the radiant is near right ascension 18h. 04m., declination + 33°.

Announcements

THE Council of the Royal Microscopical Society has made the following elections to honorary fellowship of the Society: Dr. Edwin H. Land, president of the Polaroid Corporation, Cambridge, Massachusetts, in recognition of his contributions to microscopy; Dr. Maria Rooseboom, curator, National Museum for the History of Science, Leyden, in recognition of her valuable work in connexion with the history of microscopy.

THE Council of the Iron and Steel Institute has announced the following awards for 1958: Bessemer Gold Medal for 1958, to Mr. W. F. Cartwright (Steel Company of Wales, Ltd.); Sir Robert Hadfield Medal for 1958, to Mr. W. C. F. Hessenberg (British Iron and Steel Research Association); Ablett Prizes for 1957, £50 each to Mr. C. E. H. Morris and Mr. R. N. Dale (Steel Company of Wales, Ltd.), for their paper, "Planning the Conversion of a High-lift Slabbing Mill to a Universal Mill" (*J. Iron and Steel Inst.*, April 1957).

DR. B. R. NIJHAWAN, director of the National Metallurgical Laboratory, Jamshedpur, has been given the award of 'Padma Shri' by the President of the Republic of India, in recognition of his exceptionally distinguished services in the field of science in India.

MR. J. D. HANDYSIDE has been appointed controller of research, National Institute of Industrial Psychology, with effect from April 1.

THE Institution of British Agricultural Engineers is able to offer, through the generosity of Shell Mex and B.P., Ltd., a number of bursaries for award to candidates eligible for entry to the final-year course of study leading to the examination in July 1959 for the National Diploma in Agricultural Engineering. These bursaries are normally available in units of £50, but their disbursement may be varied at the discretion of the Examination Board. The conditions governing the award may be obtained from the Secretary of the Institution of British Agricultural Engineers, 6 Buckingham Gate, London, S.W.1. The closing date for receiving completed applications is May 1, 1958.

THE Physical Society is holding a conference on "Nuclear Physics" at the Cavendish Laboratory, Cambridge, on April 10–11. Further information can be obtained from the Secretary, The Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

THE 1958 National Symposium of the U.S. Institute of Radio Engineers Professional Group on "Microwave Theory and Techniques" will be held at Stanford University, Stanford, California, during May 5–7. Further information can be obtained from Glenn H. Keitel, Publicity Chairman, 1958 PGMTT National Symposium, 601 California Avenue, Palo Alto, California.

THE 1958 International Conference on Semiconductors, sponsored by the International Union of Pure and Applied Physics, will be held at the University of Rochester, New York, during August 18–22. Further information can be obtained from M. H. Hebb, P.O. Box 1088, Schenectady, New York. Abstracts must be received by May 1.

A ONE-DAY conference on statistical sampling in industry, organized by the Birmingham Group of the Industrial Applications Section of the Royal Statistical Society, will be held at the Birmingham College of Technology on May 7. Further information can be obtained from D. Goldberg, Lamp and Lighting Co., Ltd., Melton Road, Leicester.

AN informal discussion on "The Structure and Physical Chemistry of Nucleic Acids and Nucleoproteins" will be held in the Department of Chemistry, University of Birmingham, on September 17–18, under the auspices of the Colloid and Biophysics Committee of the Faraday Society. Papers on the following topics will be read: nucleic acids (especially ribonucleic acid), synthetic polynucleotides, nucleoproteins. Members of the Faraday Society and others who wish to take part should notify Dr. A. R. Peacocke, Department of Microbiology, University of Birmingham, Edgbaston, Birmingham 15, to whom titles of papers should be sent before June 1.

THE essay subjects for this year's *Endeavour* Prizes of the British Association for the Advancement of Science will be as follows: education for an age of science; rockets and satellites and their scientific significance; photography and cinematography in science; chemicals from petroleum; Darwinism to-day; the measurement of time. The essays must be sent in by June 1 and should not exceed four thousand words. Competitors must be less than twenty-five years old, and the prizes will be 50, 25 and 15 guineas, with two special awards of 5 guineas to those less than eighteen. Further information can be obtained from the Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1.

ERRATA. Referring to the article entitled "Non-Conservation of Parity" in *Nature* of February 15, Prof. A. Salam writes: "p. 448 (1*d*), column 2, line 5, for 'right' read 'left'; (*e*) for subscript '*L*' read '*R*'. I am grateful to Dr. J. R. Holt for pointing out these errors".

RECENT ADVANCES IN NUCLEAR PHYSICS

A NEW series of meetings has been inaugurated at the Royal Society at which normally three Fellows will be invited to present statements on topics of current interest. Unlike the usual meetings for the reading of papers and the discussion meetings which are held periodically, the proceedings at these new meetings will not be published and the speakers will be free to treat the subject in a broader and perhaps more speculative manner than would be the case if their words were to be printed in the Society's *Proceedings* and *Transactions*.

The subject of the first meeting, held on February 20, was "Recent Advances in Nuclear Physics". Each of the three speakers, Profs. D. H. Wilkinson, W. E. Burcham and R. E. Peierls, spoke for half an hour. They chose to discuss aspects of what is probably the most significant advance made in the past twelve years, namely, the discovery that the motions of nucleons inside a nucleus are not strongly correlated but are largely independent of each other. In nuclear structure studies discussed by Prof. Wilkinson, this phenomenon has led to the establishment of the 'nuclear shell-model', in which, as a first approximation, nucleons in a nucleus move in an overall common potential V. The counterpart of the shell-model in nuclear reaction studies is the 'optical model' described by Prof. Burcham.

Prof. Wilkinson spoke specifically on "The Structure of Light Nuclei", using the shell-model to interpret the considerable body of data that has accumulated on nuclear-level schemes, transition probabilities, and magnetic moments. In applying the model, one introduces two types of forces acting on the nucleons over and above the common potential V. The first type of force is that acting between pairs of nucleons. By direct analogy with Coulomb forces acting between pairs of electrons in an atom, these forces tend to couple the orbits of the nucleons together to produce L–S coupling. The second type is that which couples the spin of each nucleon to its orbit (like the Thomas force in the atom) and tends to produce j–j coupling. In the presence of both types of forces, the coupling situation in a nucleus is described as intermediate and is characterized by the ratio of the effective strength of the inter-nucleon forces to the spin-orbit forces. This ratio is the most significant parameter available when attempting to fit observations.

Prof. Wilkinson showed an extensive series of slides representing the work of many people and containing comparisons of experimental data on various light nuclei with the predictions of the shell-model. The agreement is impressive, especially in such cases as carbon-13 and nitrogen-13, where the observed values of five different kinds of data are fitted with the same value of the parameter. A satisfactory feature of the fits is that the 'best values' of the effective strengths of the two types of forces vary smoothly with mass numbers and are in reasonable agreement with theoretical predictions.

Prof. Burcham discussed "The Optical Model and Nuclear Reactions". The optical model attempts to incorporate features of both the 'compound nucleus' model of nuclear reactions, and the shell-model of nuclear structure. Corresponding to the latter model, the effects of a nucleus on the motion of a bombarding nucleon can be represented by a real potential V, which merely deflects it. Compound nucleus formation, which occurs as a result of a collision in which the incident nucleon loses energy to a target nucleon, may be included by adding to V an imaginary iW. In the manner well known in optics, such a term represents absorption. Small values of W correspond to small absorption, that is, there is little probability of formation of compound nuclei; large values correspond to large absorption and large probability of formation of compound nuclei; moderate values correspond to intermediate situations in which the number of nucleons passing through the nucleus compares with the number that are absorbed into the compound nucleus. For any given values of V and W, one may calculate the absorption, shape-elastic and total cross-sections, and if a spin-orbit potential is included, the polarization of elastically scattered nucleons. Comparison with observation then enables the potentials to be determined.

At low energies (less than 5 MeV.) total cross-sections for neutrons exhibit variations with energy. Peaks occur at energies corresponding to single-particle resonances in the real potential V, and the fact that such peaks are observed at all means that W must be rather small (about 2 MeV., which is much less than the value of V, ~ 40 MeV.).

Observations at higher energies up to 1,000 MeV. suggest that W increases with energy up to 100 MeV., then flattens off and increases again at energies greater than 400 MeV., where absorption due to meson production is important. In contrast, V appears to decrease steadily until it becomes zero near 350 MeV. (This may be shown directly by use of the optical theorem stating that the total cross-section is equal, apart from known constant factors, to the imaginary part of the forward-scattering amplitude. The observed values of the total and forward scattering cross-sections at 350 MeV. show that the real part, which is proportional to V, must be very small.)

The optical model has proved to be very useful for the analysis of nuclear cross-sections, just as the shell-model is useful for interpreting data on nuclear structure. For many years, it was argued that the type of nucleon motion envisaged by the shell-model is in such contrast to the strong short-range nuclear forces that the model could not possibly be valid. Acceptance of the model has come only with its convincing success in applications. Now that the applicability of the shell and optical models in practice is so well confirmed, much attention has been given to the theoretical problem of understanding why the models work. Prof. Peierls devoted his talk, "The Theoretical Basis of the Shell-Model and Optical Model", to this matter.

It appears that the basic reason why nuclear forces are not nearly as effective in nuclear matter as one might guess is the action of the Pauli Principle. A system of Fermi particles with no interactions in its lowest state has one particle in each of the single-particle momentum states up to the Fermi level. When interactions are introduced, even though they

may be strong and of short range, they will not seriously modify the state, since all collisions with small momentum transfers are forbidden. Unfortunately, such an approach, using interactions containing sufficient exchange forces to produce saturation, gives too little binding-energy. The source of this discrepancy appears to be the fact that nuclear saturation arises only partly from exchange forces, another cause being the infinitely repulsive core in the nuclear interaction. The presence of this core means that shell-model wave-functions cannot possibly be correct when any two nucleons are separated by just the range of the core. Nevertheless, since the range of the core is considerably smaller than the mean inter-nucleon spacing, they are expected to be correct otherwise. Mathematical techniques have been developed for taking account of the effects of the cores in the wave-functions, and it is believed that one has, in principle, a reliable scheme for computing nuclear properties, especially binding-energies, using realistic nuclear forces. The main trouble, in practice, is the great labour involved in calculation. This reduces to reasonable magnitude only when considering large hypothetical systems in which surface effects are negligible. An important by-product of such calculations is the estimation of the nuclear potential, V, as a function of the momentum of a nucleon. This emerges in an iteration procedure in which one assumes values for V, then calculates new values and continues until convergence is obtained. It can be identified with the real part of the potential of the optical model, and so the calculations predict this quantity as well as the nuclear binding energies.

The meeting ended after the speakers answered a few questions from the audience. A. M. LANE

BIOCHEMISTRY OF GLUTATHIONE

THE Biochemical Society arranged a symposium on glutathione, organized by Dr. E. M. Crook and held on February 15 at the Senate House, University of London. As indicated by Prof. R. H. S. Thompson's opening remarks, the subject is attractive in bringing together a wide range of disciplines: purely chemical and analytical studies, plant and animal biochemistry, and pharmacology, toxicology and general biology.

The metabolism of glutathione in plants is notable, as described by Dr. L. W. Mapson (Low Temperature Research Station, Cambridge), for the well-defined systems which catalyse both oxidation and reduction at its sulphide group. Glutathione reductase has been found in most organisms in which it has been sought. More characteristic of plants than animals is dehydroascorbic acid reductase, which catalyses the interaction of reduced glutathione with the oxidized form of ascorbic acid. The reduced ascorbic acid formed can be oxidized by established routes, and about a quarter or a half the oxygen uptake of preparations of germinating pea cotyledons may proceed by this route, providing an example of the respiratory function envisaged for glutathione by Hopkins and others. However, attempts to demonstrate the generation of high-energy bonds during these changes have so far been unsuccessful.

Glutathione in Animal Tissues

In animal tissues there appears relatively little scope for this route of oxidation; but oxidation by purely chemical routes, for example, by exchange with other disulphides, can readily occur. This and other aspects of the chemistry of glutathione were surveyed by Dr. F. A. Isherwood (Low Temperature Research Station, Cambridge); thus transacylation also occurs spontaneously between the thiol group of glutathione and S-acyl compounds. Oxidation and mercaptide formation at the glutathione thiol group form the basis of two analytical methods for glutathione described in detail by Dr. C. G. Thomson (Institute of Psychiatry, London), who compared results with these methods with those obtained using glyoxalase. A considerable measure of agreement was found when these techniques were applied to blood and to cerebral tissues. Each tissue, however, presents its own problems in fixation, extraction, and the presence of substances likely to interfere in assay, as was evident also from discussion.

Reviewing glutathione in animal tissues generally, Dr. P. C. Jocelyn (University of Edinburgh) described recent studies of its synthesis. Synthesis proceeds through γ-glutamylcysteine and is catalysed by two distinct synthetases in tissues including erythrocytes and liver. In the liver, the synthesis appears to be affected by growth hormone and adrenaline; the extent to which vitamin B_{12} is involved in the maintenance was also appraised. Although glutathione has been suggested as a substrate in the further synthesis of proteins, experiments on incorporation of amino-acids into ovalbumin, and other lines of evidence, have failed to support the idea.

In neural tissues, Prof. H. McIlwain (Institute of Psychiatry, University of London) described the determination of glutathione in the brain fixed rapidly *in situ*, and its maintenance during *in vitro* experiments. Assimilation, synthesis, and breakdown of glutathione in cerebral tissues proceed at relatively slow rates, as also does its acylation. Deacylation is more rapid, especially of an acetylglycyl glutathione. Enzyme catalysis of the oxidation of glutathione has not been found, but the tissue possesses a very active glutathione reductase which forms the main route of oxidation of reduced triphosphopyridine nucleotide. This system operates at nearly maximal rate at the low concentrations of oxidized glutathione and of reduced triphosphopyridine nucleotide which are native to the tissue. Indeed, its operation would appear to be the main factor in securing the great preponderance of the reduced form of glutathione normally found *in vivo*, and to be necessary if glutathione is to perform the role so often ascribed to it, of maintaining thiol enzymes and coenzymes in their active, reduced, forms. Participation of glutathione in cerebral carbohydrate metabolism is well established, and change in level of blood glutathione has been reported to be associated with mental disease. Administration of large quantities of glutathione to

man with the intention of altering mental status has displayed the relatively small central effects produced in this way, in distinction to the marked effects of other thiols on the nervous system. Blood constituents are, however, altered by the administration of such quantities.

Analogues of glutathione have been found to occur naturally in the lens of the eye. Their isolation was described by Dr. S. G. Waley (Nuffield Laboratory of Ophthalmology, Oxford); they differ from glutathione at its cysteinyl residue, ophthalmic acid being γ-glutamyl-α-amino-*n*-butyrylglycine, and norophthalmic acid the alanyl derivative. They appear to be produced in the lens by the system which synthesizes glutathione, for competition can occur when substrates for more than one product are provided. Glutathione synthesis is affected also by the X-irradiation which induces cataract; after exposure, the glutathione concentration in the lens falls, but causal relationship between this change and the cataract is still under investigation. A further intriguing product isolated from the lens is S-sulphoglutathione, which can be formed from sulphite and oxidized glutathione.

Radiation Damage; Glyoxalase

In reviewing relationships between thiols and radiation damage generally, Dr. D. B. Hope (M.R.C. Radiobiological Research Unit, Harwell) described the inactivation of thiol enzymes brought about *in vitro* by irradiation. This has not been observed *in vivo*, so the enzymes involved are in some way protected, and attempts have been made to enhance the normal protection by administered substances. Glutathione to a small extent protects mice from the lethal effects of X-irradiation, but cysteamine, dithiocarbamates, and other compounds are more effective; they have in common the property of lowering the body temperature of animals.

Interesting points regarding glyoxalase came from several contributors. This is the system converting methylglyoxal to lactic acid, in which coenzyme status for glutathione was first established, and which once appeared to constitute the main route of glycolysis in many organisms. Its displacement from this role was exemplified in cerebral tissues: lactic acid formation from methylglyoxal, though rapid, is inadequate to account for the high rates at which lactic acid was afterwards found to be produced from glucose. That the glyoxalase system comprises two enzymes, adumbrated by F. G. Hopkins in his posthumous paper with E. J. Morgan, is generally agreed. Perhaps surprisingly, the immediate substrate for glyoxalase I is still debated, Dr. Waley's evidence favouring the hemimercaptal between glutathione and methylglyoxal. In this system in the lens, ophthalmic acid acts as a competitive inhibitor. Glyoxalase I yields S-lactoylglutathione, the substrate of glyoxalase II. However, a preparation from cerebral tissues is reported to hydrolyse at least one other substrate more rapidly than glyoxalase intermediate: this is S-acetylglycylglutathione. Hydrolytic enzymes have also been found in mouse liver which are specific to S-acyl derivatives of glutathione.

Concluding remarks by Dr. C. P. Stewart (University of Edinburgh) emphasized these and other aspects of the biochemistry of glutathione in which further investigation is still required. He indicated how studies of radiation damage, and the *S*-sulphoglutathione from the lens, offer hints on compounds intermediate in the conversion of —SH to —S.S— glutathione, a process likely to involve two stages.

NATIONAL OCEANOGRAPHIC COUNCIL

ANNUAL REPORT 1956–57

THE report of the National Oceanographic Council for 1956–57 (pp. v+34. Cambridge: At the University Press, 1957. 5*s.* net) describes the work carried out by the National Institute of Oceanography during the year ending March 31, 1957. The activities cover the two main fields of marine physics and marine biology, and follow the broad objectives set in previous years.

In marine physics, the technique of determining deep currents by tracking a neutrally buoyant float, drifting freely at a predetermined depth, has been exploited further. The most significant piece of work was the discovery of a southerly-flowing deep current, at depths greater than 2,500 m., beneath the Gulf Stream. This was achieved in the course of a joint expedition by R.R.S. *Discovery II*, and the U.S. research vessel *Atlantis* to an area about 150 miles off the coast of South Carolina. Other measurements of deep currents were made during the year in the Faeroe-Shetland Channel, off the Sogne Fjord, and in a region north of Madeira.

Waves and swell have been one of the Institute's main interests since its inception, and during the past year or two increasing attention has been given to their effects on the rolling, pitching and heaving of ships. The work on this subject has attracted much interest among scientists and engineers concerned with ship motion, in Great Britain and in the United States. A series of theoretical papers has also been published, treating the statistical properties of waves as those of a random, moving surface. Other studies of waves include their relation to microseisms and the relation of both to the movements of storms generating them. Turning to waves on a longer time-scale, basic research with a bearing on storm surges has been continued, both by mathematical models and by electrical analogue techniques.

The productivity of oceanic waters is one of the Institute's major objectives in marine biology, and advances have been made in instrumental and operational techniques for this purpose. An example of this is provided by work on the quantitative sampling of zooplankton from water layers at various depths. Research at sea on organic productivity included three weeks observations in one position, 600 miles west of Portugal, during the autumn of 1956. Repeated measurements were made from *Discovery II* of the light energy, rate of photosynthesis and the standing crop of phytoplankton and zooplankton.

Another broad field of investigation concerns the oceanic distribution of marine organisms. Compre-

hensive studies have been made of the distribution of various species of the plankton fauna in the Southern Ocean and in the Benguela Current. An interesting feature is the tendency for populations of different species of zooplankton to be segregated in concentric circumpolar zones. A technique for obtaining underwater photographs of squid has been developed and used successfully at depths of 300–1,000 m.

Work has been continued on the distribution and life cycles of whales, a knowledge of which is required in formulating international regulations. An investigation is being made of two alternative methods of age determination in baleen whales: by the laminations in the ear plugs and from the accumulated corpora albicantia in the ovaries. A comprehensive paper has been published on the biology of sperm whales, and a study of ambergris is in progress. Work is also being done on the geographical distribution of the various species of whale and their movements between one ocean area and another.

R.R.S. *Discovery II* was kept in full commission throughout the year, although for three months she was on hire to the Admiralty and so not employed on the Institute's research programme. For six weeks in July–August 1956 the ship was lent to the Department of Geodesy and Geophysics of the University of Cambridge, for a cruise to the Mid-Atlantic Ridge, which included seismic studies and measurements of heat flow through the sea bed.

The Institute has continued to be directed by Dr. G. E. R. Deacon with Dr. N. A. Mackintosh as deputy director. Its total staff is about eighty (excluding the officers and crew of *Discovery II*), of whom thirty-six are in the scientific and experimental officer grades. In addition, seven visiting scientists from overseas were working in the Institute during the year. The expenditure on the year's work amounted to £193,000, of which £78,000 was for running *Discovery II*. The main source of income was £110,000 in grants from the United Kingdom Government. Commonwealth Governments contributed £9,000. The Treasury has decided to increase its grants to £175,000 per annum for the next five years and this should go a long way towards ensuring the further development of the Institute's research programme.

K. F. Bowden

OPENCAST MINING

THE Opencast Coal Bill, which had an unopposed second reading in the House of Commons on January 22, is a complicated Bill which replaces the powers at present exercised under Defence Regulations by a system of planning control, acquisition and compensation incorporating some of the main points made in the Franks report. It provides that no opencast operations can take place without the permission of the Minister, who will, in his consent, insert conditions ensuring that damage is reduced to the minimum, and, when agricultural land is affected, that the land be restored to a reasonably fit state for agriculture.

It is intended to proceed wherever possible by agreement, and the compulsory rights order when used will give the Coal Board the right for a maximum of ten years to use the land for opencast mining. In moving the second reading, the Paymaster-General, Mr. R. Maudling, said there would be a continuing need for opencast coal for a considerable period: about 160 million tons of coal had been produced by this method from 109,000 acres, 13·5 million tons of this in 1957, and the need was generally but reluctantly accepted by the House; though Mr. Maudling, and Mr. A. Robens for the Opposition, alike recognized the damage done to amenity and agriculture and our duty to hand on the land in a better and not a worse condition.

While Mr. G. Nabarro condemned opencast mining generally but supported the Bill, Mr. M. Philips Price and Mr. R. Speir pressed more specifically for safeguards and greater attention to amenity both in mining and in restoring the land. In replying on the debate, the Parliamentary Secretary to the Ministry of Power, Sir Ian Horobin, urged that, given the need for opencast mining, while the provisions of the Bill were not perfect, they were probably the best we could make. The vital question of amenity had not been overlooked and would be permanently in the minds of the Ministers who had to administer the Act. Improvements could possibly be made during the Committee stage and compensation would no longer be arbitrary.

ANIMAL HEALTH IN GREAT BRITAIN

ANYONE interested in the health of domesticated animals and in their transit to and from Great Britain should read the "Report on the Animal Health Services in Great Britain 1956" (H.M.S.O., London, 6*s*. net), which includes a report on proceedings under the Diseases of Animals Act, 1950. The outstanding features of the report are, on the debit side, the high incidence, during 1956, of foot and mouth disease and anthrax, and the increase of fowl pest; but these liabilities were offset by the steady progress of the Ministry of Agriculture's scheme for the eradication of tuberculosis from cattle in Great Britain, by the demonstration by the Ministry's veterinarians in the Isle of Wight that warble fly disease can be substantially reduced by co-operation between the veterinarian and the farmer, and by the evidence provided in the report of the very wide range of research that is being devoted to the diseases of domesticated animals.

The year 1956 was the worst year for foot and mouth disease since the widespread outbreaks of 1951 and 1952. In 1956 there were 162 outbreaks, but these were confined to England and Wales. Of the 162 outbreaks, thirty-two, which had no known connexion with other outbreaks, were attributed either to swill or to imported meat, bones or meat wrappers, and it was concluded that the disease came from the Continent. It was necessary to slaughter 10,547

cattle, 13,123 sheep, 4,793 pigs and 42 goats, and compensation paid amounted to £824,658.

Anthrax also increased during 1956, although the average mortality from this disease continued to be very low. The disease was very widespread and Yorkshire was especially severely affected. Circumstantial evidence suggests that the outbreaks were caused by imported concentrated foodstuffs, though the infection could not be traced to any particular ingredient of these.

Swine fever, on the other hand, showed a decline of nearly 50 per cent during 1956, when there were only 741 outbreaks, the lowest figure since 1950. In November 1956, the Swine Fever (Infected Areas Restrictions) Order came into force, the object of which is to make possible the speedy imposition of restrictions on the marketing and movements of pigs in areas in which swine fever is prevalent. Fowl pest increased during 1956 and involved the destruction of 1,205,181 birds and 1,005,023 hatching eggs at a cost of £1,371,710 in compensation. Of the 956 outbreaks of this disease, 550 occurred among the dense poultry population of Lancashire, while 121 occurred in Lincolnshire and 84 in Essex; but twenty-one English counties and the whole of Scotland were free from this disease.

A review of suggestions for the control of warble fly led to the conclusion that, until a dressing can be found that will kill the maggots of this fly while they are in the bodies of cattle, the only method of control is to achieve greater compliance with the Warble Fly (Dressing of Cattle) Order of 1948, and a campaign for this purpose was conducted, which included the showing of a film and announcements by poster, in the Press and on the radio. The fine summer of 1955 favoured the laying of eggs by the warble fly on the hairs of cattle, and measures were taken to meet the expected increase in 'warbles' which occurred in 1956. There are in the Isle of Wight about 600 herds of cattle, and the report shows that, as a result of the work of the Ministry's veterinarians, the numbers of herds in the island completely free from warble infestation were 97 in 1954, 374 in 1955 and 500 in 1956, with a corresponding reduction each year in the numbers of individual animals affected. A considerable degree of control has thus been effected by means of effective dressings applied at the right time and by co-operation between the veterinarians and the farmers.

An important section of the report describes the good progress that has been made towards the complete eradication of tuberculosis from British cattle. The Tuberculosis (Attested Herds) Scheme, started in 1935, is entirely voluntary, and the report shows that, by the end of 1956, there were 7 million attested cattle in Britain, representing 67 per cent of the total. A map shows the attested areas in the west of Scotland, the Lake District and south and mid-Wales as they existed on January 1, 1957, and the areas in which free tuberculin tests have been available in 1955 and 1956. These include north Wales, an area south of the Lake District and the counties between the Devon border and the east coast of Kent. The testing of cattle is supported by veterinary detection of tuberculous cows liable to infect the milk supply, though these are now rarely found.

Another section of the report describes the work being done on the incidence of *Brucella melitensis*, which causes human Malta fever in the Mediterranean area. This organism has been found either in milk or in the aborted fœtuses of cows, on forty-two farms in Britain, but there is no evidence that it has ever caused human illness in the United Kingdom. The slaughter of cattle infected with it has therefore been discontinued. It is not known why this organism, which is a near relative of *Brucella abortus*, the cause of contagious abortion in cattle (Bang's disease), should cause human illness in the Mediterranean area but not in Britain.

The very detailed regulations designed to protect animals in transit to and from the United Kingdom are emphasized in the report, which discusses, with valuable statistics, the export and import of horses, asses, mules, pigs and cattle. A Government inquiry into the export of cattle to the Continent was initiated in 1957, from which developments may be expected in the next report.

The report also describes the wide range of research that is going on at the Ministry's centres of research and veterinary investigation. This research includes studies of every disease or infection that may be encountered in Britain and some that are found elsewhere.

G. Lapage

REDUCTION OF ORGANIC HYDROPEROXIDES BY MICRO-ORGANISMS AND ANIMAL TISSUES

By Dr. D. M. Updegraff and Dr. F. A. Bovey

Minnesota Mining and Manufacturing Co., Saint Paul 6, Minnesota

During the course of investigations of the bactericidal and bacteriostatic action of organic hydroperoxides, it was observed that 0·01 per cent solutions of several hydroperoxides, including *t*-butyl, *p*-menthane and cumene hydroperoxide, in nutrient media, inhibited the growth of *Escherichia coli* and *Bacillus subtilis* only temporarily. Analysis of the cultures showed that the hydroperoxide had disappeared less than 24 hr. after growth began. The known peroxide-decomposing enzymes, catalase and peroxidase, are not reported to decompose the peroxides employed here, but only methyl and ethyl hydroperoxides in addition to hydrogen peroxide itself, and it therefore appeared to be of interest to investigate this reaction further.

The concentration of hydroperoxide in bacterial cultures was determined directly with a manual polarograph, using a voltage of 1·0 V. vs. sat. calomel electrode; calibration curves showed that the waves for all the peroxides employed were fully developed at this voltage. Bacteria were grown on the surface of tryptone–glucose–yeast extract agar, harvested in 0·1 *M* *p*H 6·9 phosphate buffer, centrifuged down, and resuspended in fresh phosphate buffer.

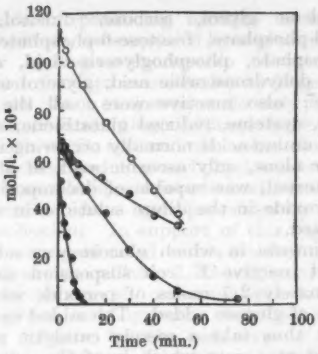

Fig. 1. Decomposition of organic hydroperoxides by *E. coli*. ○, *t*-butyl hydroperoxide; ◑, *p*-menthane hydroperoxide; ◐, cumene hydroperoxide (2×10^9 cell/ml.); ●, cumene hydroperoxide (10^{10} cells/ml.)

Plant and animal tissue homogenates were prepared in the same buffer by means of a Virtis homogenizer.

Determinations of catalase activity were also carried out on these same suspensions, suitably diluted when necessary, by measuring the rate of disappearance of hydrogen peroxide polarographically at 1·5 V. As hydrogen peroxide is decomposed by catalase, the oxygen produced gives a wave which almost exactly replaces that of the disappearing hydrogen peroxide, and it was therefore ordinarily necessary to sweep out the oxygen with a stream of nitrogen before measuring the hydrogen peroxide wave. If this was not done, the current at 1·5 V. underwent little or no change. In many cultures, however, the endogenous uptake of oxygen was at least as fast as the decomposition of hydrogen peroxide by catalase, and in these circumstances, nitrogen sweeping could be omitted. Peroxidase activity was measured similarly in the presence of 0·04 *M* pyrogallol; this measurement is grossly inaccurate unless the peroxidase activity is at least comparable to the catalase activity, since the two enzymes compete for the hydrogen peroxide. If the catalase and peroxidase activities are comparable, the peroxidase activity is given approximately by the increase in the rate of disappearance of hydrogen peroxide when pyrogallol is added. When endogenous respiration is very small or zero, peroxidase activity can also be measured as the apparent rate of decrease of the hydrogen peroxide wave at 1·5 V. in the presence of pyrogallol, for oxygen is not produced when hydrogen peroxide is decomposed by peroxidase. Since the measurement of peroxidase activity is often rather uncertain, the reporting of a zero activity only means that it was too small to be measurable by these means, and also that no visible purpurogallin colour developed in the culture on adding pyrogallol.

Control experiments established that beef-liver catalase (Armour), even in concentrations as high as 0·075 K.U. per ml., does not decompose the organic hydroperoxides employed in this study, either in the presence of cells (made inactive by heating) or in the buffer alone. However, 10^{-3} times this concentration of the same catalase preparation rapidly decomposed hydrogen peroxide. Likewise, horseradish peroxidase has no effect in buffer or cell suspensions containing 0·04 *M* pyrogallol, or in cell suspensions without pyrogallol.

In Table 1 are presented the rates of decomposition of cumene hydroperoxide, purified by preparation of the sodium salt, by 17 species of bacteria, yeasts, moulds, preparations of mammalian tissue, and plant tissue. The bacterial activities are reported as moles per minute per cell ($\times 10^{15}$), whereas the activities of the other systems are given only qualitatively. Catalase activities are reported in all cases, and peroxidase activities for eleven systems. Fig. 1 illustrates the rate of decomposition of cumene, *t*-butyl and *p*-menthane hydroperoxides by *Escherichia coli* suspensions. Initial peroxide concentrations were usually made approximately $6{\cdot}5 \times 10^{-4}$ *M*. The rates are neither exactly zero nor first order, but are intermediate and vary somewhat with the peroxide concentration and the cell count. It can be seen that cumene hydroperoxide is decomposed by fourteen of the seventeen species of bacteria tested, by the yeasts and by the animal tissues, but not by the mould, *Aspergillus niger*, or the plant tissues. Catalase activity is usually accompanied by cumene hydroperoxide-decomposing activity, but this is not necessarily so, as these three last-mentioned examples show. On the other hand, no clear evidence was obtained that cumene hydroperoxide-decomposing activity can occur without accompanying catalase activity, although there is no quantitative correlation between these activities. Consequently, anaerobic organisms, which usually show no catalase activity, show likewise no activity toward cumene hydroperoxide. A possible exception is the obligate anaerobe *Veillonella gazogenes*, which shows very strong cumene hydroperoxide-decomposing activity and only very weak catalase activity. This last observation strongly suggests that the cumene hydroperoxide-decomposing system has little or no effect on hydrogen peroxide.

Table 1. Cumene Hydroperoxide Decomposing Activity in Micro-organisms and Tissues

Organism or tissue	Activity, mol./min./cell × 10^{15}		
	Cumene hydroperoxide decomposing activity	Catalase activity	Peroxidase activity
1. *Micrococcus pyogenes* var. *aureus*	4	3	0
2. *Escherichia coli*	5	50	0
3. *Erwinia carotovora*	0·9	5·3	0
4. *Bacillus subtilis*	7	6·2	0
5. *Streptococcus faecalis*	0	10	0
6. *Leuconostoc mesenteroides*	0	0	0
7. *Pseudomonas aeruginosa*	4	4	1
8. *Serratia marcesens*	2	24	0
9. *Alcaligenes viscosus*	4·2	5	—
10. *Alcaligenes faecalis*	1·1	2·7	5·3
11. *Aerobacter aerogenes*	0·47	7·5	—
12. *Neisseria catarrhalis*	0·83	4·1	—
13. *Proteus morganii*	0·45	86	—
14. *Micrococcus lysodeikticus*	2·3	+	—
15. *Veillonella gazogenes*	6·3	weak	—
16. *Propionibacterium pentosaceum*	16	+	—
17. *Clostridium perfringens*	0	0	—
18. *Saccharomyces cerevisiae*	strong	strong	—
19. *Saccharomyces carlsbergiensis*	strong	strong	—
20. *Candida albicans*	strong	strong	weak
21. *Aspergillus niger*	0	strong	0
22. Beef liver (fresh)	strong	strong	—
23. Pigeon liver (acetone powder)	strong	strong	—
24. Hog kidney (acetone powder)	strong	strong	—
25. Hog pancreas (acetone powder)	strong	strong	—
26. Spinach (fresh)	0	strong	—
27. Oak leaves (fresh)	0	strong	—

+ Not tested by us, but known from the literature to be positive.
— Not known.

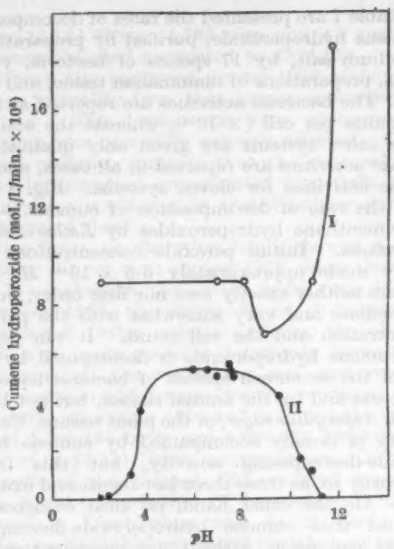

Fig. 2. Effect of *p*H on rate of reduction of cumene hydroperoxide. ○, ascorbic acid in 0·1 *M* phosphate buffer; ●, *E. coli* and glucose in 0·1 *M* phosphate buffer

It appears likely that the hydroperoxide-decomposing activity of animal cells is to be attributed to ascorbic acid, which is known to be widely distributed in mammalian tissues, and which is capable of rapidly decomposing cumene hydroperoxide even when both are at low concentrations. Curve I of Fig. 2 shows the initial rate of reduction of cumene hydroperoxide, initially 0·00055 *M*, by initially 0·00095 *M* ascorbic acid in 0·1 *M* phosphate buffer, as a function of *p*H. (Trace amounts of copper are required to achieve an appreciable rate; it is well known that the autoxidation of ascorbic acid likewise requires copper.) This behaviour is in contrast to the broad bell-shaped curve of dependence of the rate of decomposition by *E. coli* on *p*H (Curve II, Fig. 2). The activity of mammalian cells is also distinguished from that of bacteria or of yeast in being undiminished by heating for 10 min. at 100° C.; the activity of *E. coli* and of baker's yeast is destroyed by heating to 70° for 1 min.

The activity of *E. coli* was found to be dependent on the presence of cofactors found in yeast extract. It has been observed that 'old' cells of *E. coli*, that is, those harvested after more than 24 hr. growth, show greatly reduced or no activity toward hydroperoxides, but that activity can be restored by the addition of a dilute solution of yeast extract. More than fifty different substances of biochemical interest were then tested, and their potencies in restoring activity, measured as initial rate of cumene hydroperoxide decomposition, were determined. Many carbohydrates were active, including mannitol, glucose, galactose, mannose, sucrose, arabinose, fucose, glucosamine, glucuronic acid, glucuronolactone, galacturonic acid, ribose, rhamnose, acetyl-α-amino glucose, fructose, dextrin and glucose-1-phosphate. Sodium formate and hydrogen were also active. Compounds tested and found inactive included the following carbohydrates and related compounds: α-methyl glucoside, α-methyl mannoside, lactose, pentaerythritol, 2,3-butylene glycol, trimethylene glycol, sorbose, dulcitol, sorbitol, glucose-6-phosphate, fructose-6-phosphate, fructose-1,6-diphosphate, phosphoglyceric acid, dihydroxyacetone, dehydroascorbic acid, glycerol and sodium pyruvate; also inactive were: all the known B vitamins, cysteine, reduced glutathione, and all the common amino-acids normally occurring in proteins. In buffer alone, only ascorbic acid, of all the compounds tested, was capable of decomposing cumene hydroperoxide in the dilute solutions in which they were tested.

Experiments in which glucose was added to an 'old' and inactive *E. coli* suspension showed that approximately 2·7 moles of peroxide were reduced per mole of glucose added. The added carbohydrate does not thus take a merely catalytic role, but is consumed at a rate which is of the same order of magnitude as that of the peroxide. In *p*H 6·9 buffer alone, one mole of ascorbic acid was found to reduce two moles of cumene hydroperoxide.

The effective substances are those which can be readily fermented by *E. coli*, but it is not clear whether the Embden–Meyerhof glycolytic system is involved in view of the very broad *p*H range over which rapid reaction of cumene hydroperoxide can be observed. It appears possible that bacteria and many other organisms and tissues contain an enzyme system capable of converting fermentable carbohydrates to an intermediate form which can react rapidly with organic hydroperoxides. Ordinarily, this intermediate may occur in equilibrium at very low concentrations, and its existence may become evident only when organic hydroperoxides or other strong oxidizing agents are present. In this connexion, the dienol glucose reported by Nath and Bhattathiry[1] may be recalled.

The activity of formate and of molecular hydrogen may be attributed to the hydrogenlyase and hydrogenase systems, respectively[2]. The fact that hydrogen and formate give a lower rate of cumene hydroperoxide reduction than some of the carbohydrates is probably attributable to the extremely low solubility of hydrogen in water. Formate could be rapidly converted to hydrogen and carbon dioxide, and some of the hydrogen might be lost from the cell into the nitrogen atmosphere above the liquid.

The reduction of organic hydroperoxides might be accomplished by an enzyme system of broad *p*H

Table 2. Relation between Carbohydrate Fermentation and Cofactor Activity

Organism	Fermentation of carbohydrate listed			Cofactor activity of carbohydrate listed		
	Glucose	Glycerol	Inositol	Glucose	Glycerol	Inositol
Micrococcus pyogenes	*A*	*A*	0	+	+	0
Alcaligenes faecalis	0	0	0	0	0	0
Alcaligenes viscosus	0	0	0	0	0	0
Pseudomonas aeruginosa	0	0	0	0	0	0
Proteus morganii	*AG*	?	0	+	+	0
Aerobacter aerogenes	*AG*	?	*AG*	+	0	+
Escherichia coli	*AG*	0	0	+	0	0
Saccharomyces cerevisiae	*A*	–	–	0	–	–

A, acid (or carbon dioxide) only produced; *G*, hydrogen gas produced; ?, fermentation reaction variable or not known

range capable of producing formate or hydrogen from carbohydrate, accompanied by a system (hydrogenlyase or hydrogenase) capable of transferring hydrogen from formate or molecular hydrogen to the hydroperoxide. Such a system could only be active in carbohydrate-fermenting, hydrogenlyase-positive organisms such as *E. coli* and the other Enterobacteriaceae. Yeasts and non-carbohydrate-fermenting bacteria such as *Alcaligenes faecalis* and *Pseudomonas aeruginosa* must reduce hydroperoxides by quite a different mechanism. In support of this suggestion, experiments were performed with a number of micro-organisms, as shown in Table 2. It will be noted that in every case where an organism was known to ferment a given carbohydrate, that carbohydrate served as a cofactor for the reduction of cumene hydroperoxide. Conversely, where a carbohydrate was known not to be fermented, no cofactor activity was found. *Micrococcus pyogenes* produces acid but no gas from glucose and glycerol, and hence shows no hydrogenlyase activity; nevertheless, these compounds show cofactor activity with *M. pyogenes*.

Probably, as in the case of methylene blue reduction, a wide variety of different mechanisms may be found, in different types of organisms and tissues, for the reduction of organic hydroperoxides.

The significance of organic hydroperoxides in the metabolism of bacteria is uncertain. Probably they do not ordinarily play an important part. However, Imelik[3] has suggested that the initial product of the oxidation of hydrocarbons by bacteria is a hydroperoxide. It further appears likely that organic peroxides may play a part in the effects produced by high-energy radiation. Thus, Scholes, Weiss and Wheeler[4] were able to detect hydroperoxides in ribonucleic and deoxyribonucleic acids exposed to ultra-violet radiation, and the formation of organic peroxides in proteins exposed to high-energy radiation has been reported[5]. We suggest that the peroxide-decomposing system we have described may be important in protecting the cell against radiation-induced damage.

[1] Nath, M. C., and Bhattathiry, E. P. M., *Nature*, **176**, 1233 (1956).
[2] Gest, H., *Bact. Rev.*, **18**, 43 (1954).
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THE AGROTYPE CONCEPT IN TEA TAXONOMY

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THE special taxonomic problems posed by the tea plant are not generally known, nor was their satisfactory resolution apparent when they were first investigated at Tocklai. A classical system of nomenclature does not deal adequately with the cultivated tea plant[1].

Populations of tea bushes, nominally referred to[2] as *Camellia sinensis* L., which are used for the manufacture of tea, have a life of half a century or more. In India they are raised from seed produced in orchards of phenotypically mixed trees of the cross-bred origin described by Hunter and Leake[3]. This origin probably stems from earlier species hybrids[4]. A seed orchard is perennial, and thus genetically similar progenies of various ages come to be widely dispersed among numerous tea estates; but the orchard itself may have been forgotten or destroyed. The relative frequency of phenotypes differs greatly between progenies of disparate orchards.

Shoots from all bushes in a population are plucked and manufactured in bulk. Provided that the overall impression of 'quality' is satisfactory and the gross yield sufficiently high, wide phenotypic variation affecting *inter alia* yield and quality may be tolerated, and may possibly be a safeguard against excessive incidence of pests and diseases. There are big yield (and quality) differences between disparate progenies, yield per unit ground area being an essential criterion of agricultural efficiency.

Pure lines have not been used and are likely to have an impracticably low vigour: first-generation crosses between clones are known[4], but have not come into general use. There is accordingly great practical need for an efficient method of defining and discriminating between the mixed populations in current cultivation. Without this, it is impossible to investigate satisfactorily the influence of cultural practices and local conditions on yield, while even the most precise analysis of tea made from undefined populations is necessarily restricted in meaning.

Both quality of the made tea and yield of plucked shoots from which the tea is made differ between phenotypes; but in practice each of these attributes of individual phenotypes is automatically integrated into a single population value by the normal processes of bulk manufacture, and the integrated value becomes the yardstick by which the effect of manures and cultural treatments is measured. Investigation would be facilitated if there were important differentiating features of the phenotypes that could be integrated into a single numerical value by which the population could be given position in a taxonomic array.

To connote the concept of an integrated or average phenotype numerically defined, we have for some years used the term 'agrotype', originally proposed by Gregor[5] in connexion with the typification of crop plants. He suggested that crop populations (agrotypes) should be defined by stating the mean values and the variability of the characters, including characters of agricultural importance, chosen for typification.

A population average is possible provided the constituent individuals can be given numerical values corresponding to their expressions of the typifying feature. The condition is readily satisfied by number of unit organs exhibited, frequency of stamens, for example, or frequency of a specified type of cell. Where such a frequency is the only criterion of a phenotype employed, the agrotype of a population is simply defined by the mean frequency with its standard error.

The purpose of the present article is to show that frequency of calcium oxalate crystals in a specified

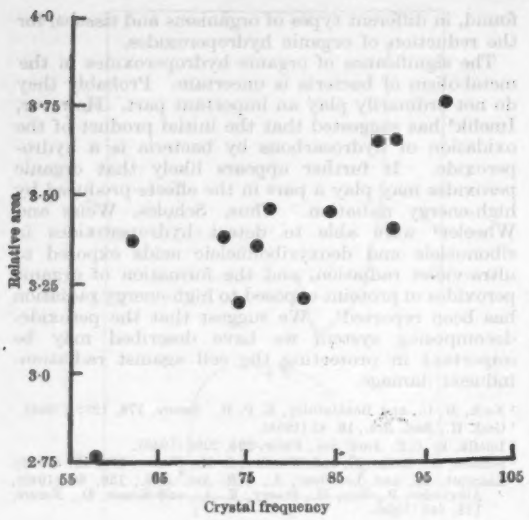

Fig. 1

region of the plant is a valuable criterion for the typification of tea populations. The crystals are in fact druses, and as only one druse occupies the lumen of a cell as seen in cross section, crystal frequency is a frequency of unit organs (cells) characterized by a particular set of chemical reactions.

Crystal frequency has been defined as total number of crystals in the phloem parenchyma of a complete cross-section of the leaf petiole[6]. Statistical analysis by Barua[7] shows that errors of counting can be kept within narrow limits. Crystal frequency has been shown to differ significantly between clones raised from seedlings of chance origin[8]; and in view of the cross-bred nature of commercial tea seed orchards, it seems likely that every tea seedling has its characteristic crystal frequency. Further, different tea populations in cultivation have been shown to differ significantly in mean crystal frequency[6].

Other mean attributes of a population have been shown to be related to the mean crystal frequency. There is a positive correlation with the number of standard shoots that can be obtained by repeated cropping or plucking[4]. This relation is subject to large seasonal and sampling errors. A similar but closer relation (shown in Fig. 1) holds between mean crystal frequency of a population and mean surface area of a bush ($r = +0{\cdot}74 : P < 0{\cdot}01$). The values shown in Fig. 1 are of relative area, square of the bush radius in feet (mean of two diameters). The Indian system of pruning and plucking results in a flat horizontal surface[9], and the method indicated has been shown to give a satisfactory measure of relative bush area.

The foregoing observations show that crystal frequency is indicative of a nature of growth (growth form) that must have an important bearing on the yield of a tea plantation: they suggest that crystal frequency may be closely related to a frequency of important genes.

In order to study the inheritance of the factors determining crystal frequency, it has been necessary to examine cross-bred progenies, since satisfactory progenies by self-pollination are difficult to obtain. Six cross-bred progenies were obtained by controlled

Table 1. Crystal Frequency of Progenies: June 1956

Mating	Parents ♀	Parents ♂	Number of plot repeats of progeny	Crystal frequency of a mean plant of the progeny
1	19/29/13	× 19/35/2	7	101·3
2	19/35/2	× 19/31/14	2	99·6
3	19/29/13	× 19/31/14	5	100·8
4	19/37/2	× 19/39/7	5	60·0
5	19/37/2	× 19/36/15	2	50·3
6	24/7	× 24/6	3	58·8
7	19/36/15	× 19/39/7	5	39·2

pollination within pairs of parents indicated in Table 1. The parents originated as seedlings from commercial orchards the cross-bred nature of which has already been noted. Depending on the amount of experimental seed obtained, varying numbers of progeny plots, each of twenty-four seedlings, were established. Mean crystal frequencies for each progeny were determined by taking one leaf from each of five seedlings, chosen at random, in each plot, in accordance with the sampling method used in earlier investigations[6]. Analysis of variance showed the progenies to differ significantly in respect of mean crystal frequency ($P < 0{\cdot}001$). Seedling differences within progenies were found to be significant ($P < 0{\cdot}001$) when tested against the variation shown by replicate microtome sections of the same leaf. The more stringent test, against field variation of vegetative replicates of the seedlings, has not yet been carried out, but real differences between seedlings would undoubtedly be expected.

Estimates of parental crystal frequency, given in Table 2, were obtained by sampling vegetative replicates, one leaf being taken from each of twelve plants, chosen at random, within a set of forty-eight vegetative replicates that had been produced from each parent.

At the time of the crystal counts the progenies were all the same age, 6 years, and the vegetative replicates of the parents were all 9 years old except for mating 6 (8 years). Parents at the time of vegetative propagation were all 30 years old except for mating 6 (10 years). All parental clones had received a common treatment, similarly all progenies; but there had earlier been differences of pruning and plucking between parents and progenies. Practical management of the plots had made it impossible to avoid a difference of about three months between the age (following annual prune) of parental shoots and those of their progeny; but it is our experience that this would have a negligible effect on the relative crystal frequencies.

Table 2. Crystal Frequency of Parents determined from Vegetatively Propagated Replicates in May 1956

Parent	Mean crystal frequency	Standard error	Name of orchard and year of seed origin of parent	Location of orchard lat. N.	Location of orchard long. E.
19/37/2	98·8	4·64	Bhatkhowa, 1917	26°40′	89°30′
19/35/2	128·1	4·63	Subong, 1917	24 55	92 50
19/29/13	117·9	3·91	Cinnamara, 1917	26 45	94 15
19/39/7	48·5	2·77	Huloongurl, 1917	26 40	94 25
19/31/14	108·9	3·95	Jaipur, 1917	27 15	95 25
24/6	77·4	5·12	Bazaloni, 1938	27 25	95 30
24/7	40·6	2·78	Bazaloni, 1938	27 25	95 30
19/36/15	26·4	1·78	Jadoo, 1917	27 30	95 35

Table 3. CRYSTAL FREQUENCIES OF PARENTS AND PROGENY

Mating	Mean value of the two parents	Mean value of the progeny
1	123·0	101·3
2	118·5	99·6
3	113·4	100·8
4	73·6	60·0
5	62·6	50·3
6	50·0	58·8
7	37·4	39·2

The mean crystal frequencies of the two parents for each mating and the mean frequencies of their progeny are given in Table 3 and the correlation is shown in Fig. 2. The correlation coefficient of + 0·98 ($P < 0·001$) shows that the crystal frequencies of progenies can be predicted from their parents with some precision. More recent observations on matings indicate that the relation continues to hold for matings between parents of even lower crystal frequency than any shown in the figure.

The foregoing observations show that the frequency of calcium oxalate crystals is an important method of defining tea agrotypes. Such agrotypes do not bear a simple relation to the varietal types of classical nomenclature; but in our experience crystal frequency is a necessary definition of tea plants for many theoretical and practical purposes. It is of similar importance as a definition of the processed shoots sold as dry tea. The frequency of calcium oxalate crystals fixes the position of individuals and populations on a scale which has a genetic basis. Use of such a scale simplifies investigation of problems connected with heterogenous populations.

I am indebted to Dr. J. W. Gregor and his staff when at Craigs House, Corstorphine, for many helpful discussions on the nature of plant populations, and to Prof. E. J. Maskell for valuable comments on presentation of the paper.

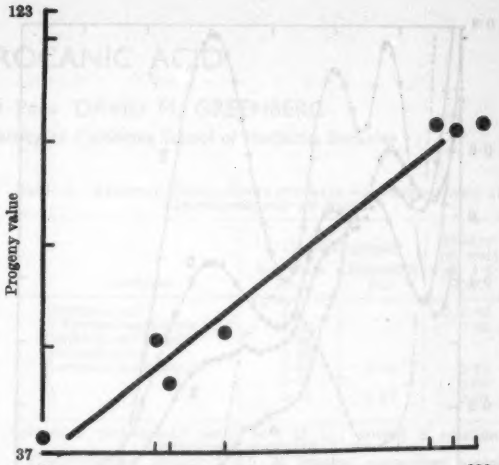

Fig. 2

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INTERMEDIATES AND COMPETING REACTIONS IN THE PHOTODESTRUCTION OF INDOLEACETIC ACID

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THE changes in ultra-violet spectrum during photodestruction of aqueous solutions of indole-3-acetic acid by monochromatic ultra-violet light of 280 mμ, in air, have been followed in parallel with the decrease in Salkowski reaction intensity and in *Avena* coleoptile growth-promoting activity. The changes in spectrum lagged behind the disappearance of indole-3-acetic acid, as estimated by either of the latter methods, in such a way as to indicate the accumulation of an intermediate having an ultra-violet spectrum similar to that of the acid. This intermediate, which will be called *M*, appears to be stable in the absence of radiation, and it undergoes further photodestruction to give the spectrum shown in curve 3 of Fig. 1. When indole-3-acetic acid labelled with carbon-14 in the 2-carbon of the indole ring was irradiated, the tracer appeared in part in a chromatographic spot (*M′*, ref. 1) of R_F somewhat greater than indole-3-acetic acid, and which gave a weak pink nitrite reaction. The amount of material in this spot (as estimated from its radioactivity), at different times during the course of the reaction, corresponded approximately with the amount of *M* which was calculated, from the spectrophotometric changes, to be present; it disappeared by the time all the indole-3-acetic acid had been destroyed. The chromatographically detected intermediate *M′* may thus be the substance *M* indicated by the spectrophotometric observations, though this remains to be proved. It appears to be the same as substance '*E*' detected chromatographically by Fischer[2] in the photo-oxidation of indole-3-acetic acid which he regarded as indole-3-glycolic acid. In our hands, however, synthetic indoleglycolic acid ran at an R_F lower than indole-3-acetic acid[2]; the intermediate *M′* appears to be neither indoleglycolic nor indoleglyoxylic acid. Its identity is not yet established.

The spectrum of the final product (Fig. 1, curve 3) shows unmistakable similarity to the spectrum of indole-3-carboxaldehyde (indolealdehyde) shown in curve 2 (Fig. 1). This compound could readily be detected on chromatograms of the reaction product[1],

* Society of Fellows, Harvard University.
† National Science Foundation Postdoctoral Fellow.

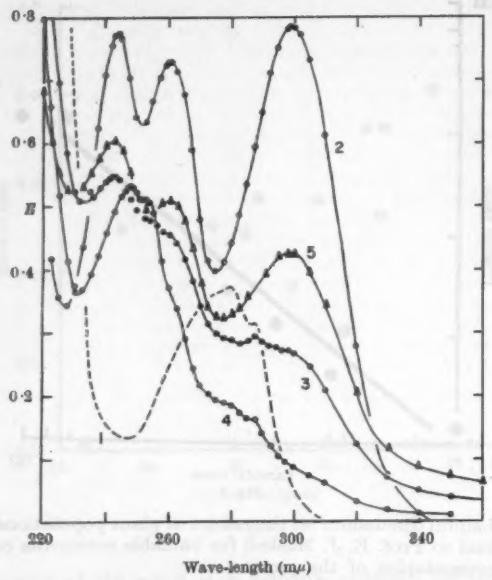
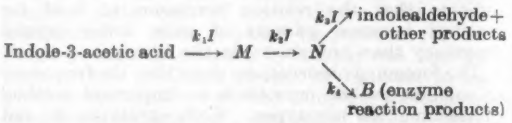


Fig. 1. Ultra-violet spectra ($6{\cdot}9 \times 10^{-5}$ *M* solutions) of indole-3-acetic acid (curve 1), indole-3-carboxaldehyde (curve 2), and photodestruction products of indole-3-acetic acid (curves 3 and 4) and indoleglycolic acid (curve 5). Curve 3, irradiation of indole-3-acetic acid at 280 mμ (90 min., 5,600 ergs/sec.) or for 4 min. at 10 cm., from an unfiltered General Electric *H85C3* 100-watt mercury lamp (quartz). Curve 4, irradiation of indole-3-acetic acid at 302 mμ (180 min., 16,800 ergs/sec.) or for 95 min. at 10 cm., from an unfiltered General Electric *AH-5* 250-watt mercury lamp (glass). Curve 5, irradiation of indoleglycolic acid for 4 min. at 10 cm. from the *H85C3* lamp. Photodestruction was carried out using 1·7 ml. of solution in a quartz cuvette of 1-cm. light path, as described previously (ref. 6) except that slit-width was 3·0 mm.

and the spot of colour corresponded with a peak of radioactivity when 2-labelled indole-3-acetic acid was used as substrate. Although these observations confirm the finding of Fischer[2] that indolealdehyde is a product, it can be seen from curve 3 (Fig. 1) that other light-absorbing materials than indolealdehyde were present in the product, and that taking these into account, indolealdehyde could have been formed at most in about 25 per cent yield from indole-3-acetic acid. The remaining products ran close to indolealdehyde on chromatograms, and were presumably neutral substances also. They were not products of photodestruction of indolealdehyde, because the latter itself was relatively little affected by a radiation dose sufficient to convert an equal amount of indole-3-acetic acid entirely into the products of curve 3 (Fig. 1). They appear to be formed from *M* along with indolealdehyde.

Irradiation of synthetic indoleglycolic acid gave the spectrum shown in curve 5 (Fig. 1). This indicates a considerably higher yield of indolealdehyde than from indole-3-acetic acid, perhaps approaching 50 per cent of stoichiometric, but there are evidently other light-absorbing materials present. Comparison of curves 3 and 5 (Fig. 1) indicates that were indoleglycolic acid an intermediate in photo-oxidation of indole-3-acetic acid, it could be formed initially only in partial yield. No direct evidence for its occurrence in photo-oxidation of indole-3-acetic acid has been obtained.

It was found, surprisingly, that when the wave-length of irradiation was varied, the spectrum of the final product also varied, even though phenomena indicative of the formation of *M* were still observed. The spectrum of the product formed by irradiation at 302 mμ or 313 mμ (curve 4) is almost identical with that of the enzymatic oxidation products of indole-3-acetic acid[4]. At 289 mμ and 297 mμ, spectra intermediate between curves 3 and 4 resulted. Neither of these products was convertible into the other by irradiation at any wave-length, so neither of them constitutes an intermediate step in the formation of the other. However, when irradiation intensity at 280 mμ was decreased, a portion of the final products also appeared in the form of curve 4. The proportion of the latter product formed at different irradiation intensities corresponded closely with what could be predicted from the kinetics of competing light- and dark-reactions acting on a second intermediate, *N*:



Curve 3 corresponds to a light intensity *I* so great that essentially all of *N* is decomposed by the light-reaction governed by k_3. The extinction of *N* is evidently negligible at 302 mμ and 313 mμ, where indole-3-acetic acid still absorbs slightly and undergoes photodestruction, so that only *B* is formed. That *N* is not indoleglycolic or indoleglyoxylic acid is shown by the fact that these are stable, under the present conditions, in the absence of radiation. It was found afterwards that the difference in reaction products described above can be obtained simply by comparing the effects of mercury lamps with quartz (curve 3) and glass (curve 4) envelopes.

These observations indicate that the photo-oxidation process is complex, and preclude its being formulated simply as a stepwise conversion of indole-3-acetic acid into indoleglycolic acid, indoleglyoxylic acid, and indolealdehyde. At the same time they indicate a much closer chemical relationship between photodestruction and enzymatic oxidation of indole-3-acetic acid than has hitherto seemed likely, and complement nicely the recent finding of Stutz[5] that the enzymatic reaction can be diverted to the formation of indolealdehyde when cytochrome *c* and a cytochrome oxidase preparation are present in addition to 'indole-3-acetic acid oxidase'.

We wish to thank Prof. K. V. Thimann for his interest in this work, Dr. Bruce B. Stowe for synthesis of indolealdehyde and indoleglyoxylic acid, and Dr. M. D. Armstrong for the sample of indoleglycolic acid. The work was supported in part by grants to Prof. K. V. Thimann from the American Cancer Society on recommendation of the Committee on Growth, and from the National Science Foundation (*NSF*–G182).

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STUDIES OF UROCANIC ACID

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Intermediate Products in the Enzymatic Degradation of Urocanic Acid

UROCANIC acid (β-imidazoleacrylic acid) is the first intermediate formed in the catabolism of histidine to glutamic acid by mammalian liver[1]. The only other intermediate which has been well characterized is N-formiminoglutamic acid.

In order to study how the imidazole ring is opened, purified beef liver urocanase was allowed to act on α-^{14}C-urocanic acid (prepared enzymatically from α-^{14}C-histidine). The enzyme was purified 30-fold by a procedure which included adsorption with bentonite, precipitation with ammonium sulphate and fractional extraction of the ammonium sulphate precipitate. The enzyme activity was assayed by the spectrophotometric method of Tabor and Mehler[2].

Upon fractionation of the radioactive incubates, evidence was found for the formation of two products, one having an ultra-violet absorption peak at approximately 264 mμ (I), and the other (II) having an end-absorption. Comparison by paper chromatography showed that neither of these products was N-formiminoglutamic acid (Table 1), nor was N-formiminoglutamic acid found in any of the incubation mixtures, even when the incubation was allowed to proceed until no urocanate remained.

Spots of I and II on paper gave no colour when sprayed with Pauly's diazo reagent or with alkaline ferricyanide-nitroprusside reagent (an amidine test)[3]. Compound II was found to give a delayed ninhydrin reaction upon prolonged heating. It can be separated from I and purified by paper electrophoresis at *p*H 4·6 (Table 1). At this *p*H it is negatively charged, while I is approximately neutral. Synthetic formyl-L-isoglutamine was not separable from II by paper chromatography (with two solvents), or by paper electrophoresis (Table 1). Consequently, II appears to be formylisoglutamine.

Isolation of formyl-D,L-isoglutamine as a product of urocanase action was reported by Oyamada[4]. Formyl-L-isoglutamine has been synthesized and found to be microbiologically inactive[5,6]. Thus, probably it is not on the enzymatic pathway.

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Table 1. RELATIVE ZONAL MOVEMENT WITH CHROMATOGRAPHY AND ELECTROPHORESIS ON PAPER

Substance	Chromatography		Electrophoresis
	Solvent *A* R_{uro}	Solvent *B* R_{uro}	*p*H 4·6 R_{pic}
Urocanic acid	1·0		0, 0·05
N-formiminoglutamic acid	0·52		0·82
Formylglutamic acid	0·82		
Glutamic acid	0·26		
Formyl-L-isoglutamine	0·93	0·95	0·75
I	0·95		0·01
II	0·91	0·97	0·74

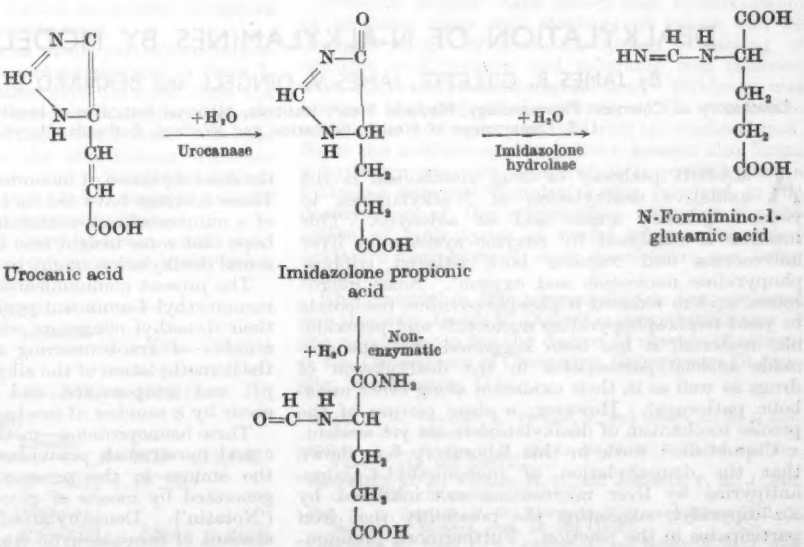
Solvent *A*, propanol–1*N* acetic acid (3 : 1); solvent *B*, *t*-butanol–formic acid–water (14 : 3 : 3)
Electrophoresis medium: 0·2 *M* triethyl ammonium acetate. R_{uro} and R_{pic} are movements relative to urocanic acid and picrate, respectively

Formation of I was found to parallel the disappearance of urocanic acid, with no observable time lag. The ultra-violet absorption of I rapidly disappeared when it was mixed with crude liver extract. Neutral solutions of I are unstable at room temperature. Aged solutions of I contained large amounts of II.

The ultra-violet absorption, electrophoretic behaviour and instability of I lead us to propose that it is 4,(5)-imidazolone-5, (4)-propionic acid[7] (see scheme of reactions). The formation of formylisoglutamine by non-enzymatic hydrolysis is consistent with this proposal.

The reactions shown below account for our findings. They are similar to the proposals of others[4,5].

This work was aided by a research grant from the National Cancer Institute (*CY*-3175), United States Public Health Service.



We are indebted to Dr. H. Tabor, National Institutes of Health for a sample of N-formiminoglutamic acid, and to Drs. A. Miller and H. Waelsch, of the College of Physicians and Surgeons, Columbia University, for a sample of formyl-L-isoglutamine.

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Dye Reduction by a Metabolite of Urocanic Acid

Miller and Waelsch[1] have reported that mixtures of urocanate with cat liver urocanase reduce such hydrogen acceptors as 2,6-dichlorophenol, indophenol and ferricyanide. This led them to propose a step involving oxidized urocanate and reduced enzyme as an intermediate of urocanase action.

Our preparation of partially purified beef urocanase when incubated with urocanate and the above dye reduced the dye at a higher rate than Miller and Waelsch reported. Further investigation showed that the dye reduction proceeded rapidly and non-enzymatically in neutralized trichloracetic acid deproteinized incubation mixtures in which urocanate was exhausted. Potassium ferricyanide was used in spectrophotometric studies to show that addition of this hydrogen acceptor caused an immediate reduction in the 264-mμ peak of imidazolone propionic acid presumed to be present in the mixtures.

The rapid reduction of dye by imidazolone propionic acid indicates that this metabolite is susceptible to oxidation as well as hydrolysis. This suggests that imidazolone propionic acid may be an intermediate of the oxidation of urocanic acid described by Ichihara *et al.*[2].

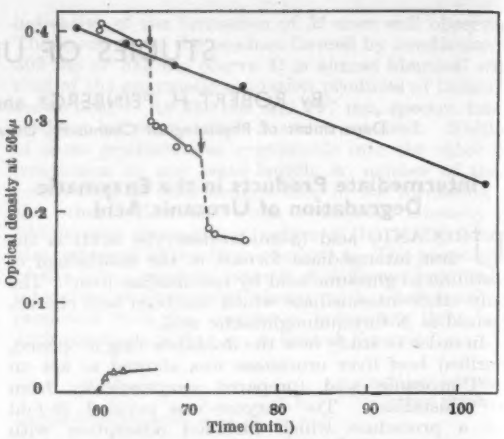

Fig. 1. Effect of addition of ferricyanide on the absorption of incubation mixtures of urocanic acid at 264 mμ. The incubation mixture contained 0·5 μmole of urocanate, 40 μmoles of phosphate buffer, *p*H 7·1, and 2 mgm. of purified urocanase in total volume of 2·9 ml. Urocanate was exhausted at about 40 min. (in line designated by ○). At the points indicated by arrows, 0·1 ml. (0·05 μmole) of potassium ferricyanide was added; ●, same with no ferricyanide added; △, same with urocanate omitted. Readings are against enzyme blank at 25° C.

Our results do not bear out the proposal of Miller and Waelsch that an oxidation product of urocanic acid is an intermediate of urocanase action.

This work was aided by research grants from the National Cancer Institute (*CY*-3175 and *C*-2869C), United States Public Health Service.

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DEALKYLATION OF N-ALKYLAMINES BY MODEL SYSTEMS

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A MAJOR pathway of drug metabolism is the oxidative dealkylation of N-alkylamines to yield a primary amine and an aldehyde. This reaction is catalysed by enzyme systems in liver microsomes and requires both reduced triphosphopyridine nucleotide and oxygen[1]. Since microsomes oxidize reduced triphosphopyridine nucleotide to yield triphosphopyridine nucleotide and peroxide-like material, it has been suggested that the peroxide moiety participates in the dealkylation of drugs as well as in their oxidation along other metabolic pathways[2]. However, a clear picture of the precise mechanism of dealkylation is not yet evident.

Unpublished work in this laboratory has shown that the demethylation of monomethyl-4-aminoantipyrine by liver microsomes was inhibited by α,α′-dipyridyl, suggesting the possibility that iron participates in the reaction. Furthermore, preliminary studies demonstrated that methæmoglobin and a hydrogen peroxide generating system catalysed the demethylation of monomethyl-4-aminoantipyrine. These findings have led us to investigate the action of a number of iron-containing model systems in the hope that some insight into the mechanism of microsomal dealkylation might be obtained.

The present communication describes studies with monomethyl-4-aminoantipyrine, N-methylaniline and their dimethyl congeners which demonstrate that a number of iron-containing model systems promote the demethylation of the alkylamines at physiological *p*H and temperature, and that dealkylation may occur by a number of mechanisms.

Three hæmoproteins—methæmoglobin, cytochrome *c* and horseradish peroxidase—were incubated with the amines in the presence of hydrogen peroxide generated by means of glucose and glucose oxidase ('Notatin'). Demethylation, as measured by the amount of formaldehyde trapped by semicarbazide[1], was catalysed by all three systems. As the reaction did not occur in the absence of the hydrogen peroxide

Table 1. Demethylation of Monomethyl-4-aminoantipyrine (MMAP) and 4-Aminoantipyrine (AAP) by Model Systems

	Formaldehyde from MMAP	Formaldehyde from AAP
	(μmoles)	(μmoles)
Methæmoglobin ($1 \cdot 4 \times 10^{-5}$ *M*)		
In air	0·0	0·0
Plus H_2O_2 generating system	2·1	1·1
Cytochrome *c* ($6 \cdot 2 \times 10^{-5}$ *M*)		
In air	0·0	0·0
Plus H_2O_2 generating system	1·0	0·3
Horseradish peroxidase (1×10^{-5} *M*)		
In air	0·1	0·0
Plus H_2O_2 generating system	2·4	1·2
Hæmatin (1×10^{-3} *M*)		
In air	1·1	0·6
Plus H_2O_2 generating system	1·0	0·6
$FeCl_3$ (6×10^{-3} *M*) under nitrogen	5·3	3·7

Experimental conditions. (*A*) Porphyrin systems. 10 μmoles substrate, 1 ml. of 0·2 *M* phosphate buffer, *p*H 7·4, 60 μmoles semicarbazide and water to a final volume of 5 ml. were incubated in a Dubnoff metabolic shaker for 1 hr. at 37° C. under air. The hydrogen peroxide generating system consisted of 500 μmoles of glucose and 0·5 mgm. of glucose oxidase ('Notatin'). The reaction was terminated by addition of 15 ml. of 6·67 per cent trichloracetic acid. After removal of protein by centrifugation, aliquots of supernatant were assayed for formaldehyde by the chromotropic acid method of MacFadyen (ref. 3) as described in previous paper (ref. 1). (*B*) Ferric chloride system. 10 μmoles substrate and 30 μmoles of ferric chloride in 5 ml. of water were incubated for 0·5 hr. at 25° C. under nitrogen. Aliquots of reaction mixture were assayed directly for formaldehyde.

system it may be concluded that the systems functioned as peroxidases.

Hæmatin also catalysed the demethylation of the amines. It is of interest that the porphyrin could act both as a peroxidase and as an oxidase. For example, at low concentrations of hæmatin (about 2×10^{-5} *M*) hydrogen peroxide was required for appreciable activity. In contrast, at high concentrations (1×10^{-3} *M*) of hæmatin, dealkylation did not require hydrogen peroxide. Since no activity was observed anaerobically it was concluded that hæmatin at the higher concentration functioned as an oxidase.

The amines, with the exception of dimethylaniline, were also demethylated by inorganic iron when more than stoichiometric amounts of ferric chloride were used. Of particular note was the finding that this system was as active anaerobically as aerobically, showing that ferric ions served as electron acceptors in a dehydrogenase-like mechanism.

The effects of the various model systems on monomethyl-4-aminoantipyrine are summarized in Table 1. Results of a similar nature were obtained with the other amines. It is of interest that formaldehyde was also formed when 4-aminoantipyrine was the substrate, indicating that the dealkylation of monomethyl-4-aminoantipyrine and dimethyl-4-aminoantipyrine resulted in part from removal of the N-methyl group from the pyrazoline ring.

The results presented here indicate that iron-containing model systems can promote dealkylation by three types of oxidation:

(1) A peroxidase reaction:

$$R\text{—NH—CH}_3 + H_2O_2 \xrightarrow{\textit{peroxidase}} R\text{—NH—CH}_2OH + H_2O$$

$$R\text{—NH—CH}_2OH \longrightarrow R\text{—NH}_2 + HCHO$$

(2) An oxidase reaction:

$$R\text{—NH—CH}_3 + \tfrac{1}{2}O_2 \xrightarrow{\textit{hæmatin}} R\text{—NH—CH}_2OH$$

$$R\text{—NH—CH}_2OH \longrightarrow R\text{—NH}_2 + HCHO$$

(3) A dehydrogenation reaction:

$$R\text{—NH—CH}_3 + 2Fe^{3+} \rightarrow RN{=}CH_2 + 2Fe^{2+} + 2H^+$$

$$RN{=}CH_2 + HOH \longrightarrow R\text{—NH—CH}_2OH$$

$$R\text{—NH—CH}_2OH \longrightarrow R\text{—NH}_2 + HCHO$$

A hydroxymethyl intermediate has been postulated as an intermediate in the dealkylation of methylamines[4]. Our studies have provided evidence in favour of the formation of such an intermediate. When monomethyl-4-aminoantipyrine was incubated with the methæmoglobin system in the absence of semicarbazide, both formaldehyde and the primary amine were formed; on the other hand, in the presence of semicarbazide only a trace of the primary amine appeared (Table 2). These results could be explained by postulating the formation of a hydroxymethyl derivative which is stable in the incubation mixture when semicarbazide is absent, but would yield 4-aminoantipyrine when the reaction is stopped by the addition of trichloracetic acid. In the presence of semicarbazide, however, the hydroxymethyl intermediate would react, as formed, to yield formaldehyde semicarbazone and 4-aminoantipyrine. But 4-aminoantipyrine as well as aniline has been found to be very unstable in the various peroxidase model systems whether or not semicarbazide was added. This would explain the failure to find the primary amine in the incubation system which contained semicarbazide, since removal of formaldehyde would expose the free amine to destruction by the peroxidase systems.

Table 2 Effect of Semicarbazide on Accumulation of 4-Aminoantipyrine (AAP) formed from Monomethyl-4-aminoantipyrine

	AAP formed (μmoles)	Formaldehyde formed (μmoles)
Methæmoglobin ($1 \cdot 4 \times 10^{-5}$ *M*) plus H_2O_2 generating system		
without semicarbazide	2·3*	2·3*
with semicarbazide	0·2	1·9

Incubation conditions: 10 μmoles substrate, 1 ml. of 0·2 *M* phosphate buffer, *p*H 7·4, the hydrogen peroxide generating system (500 μmoles glucose and 0·5 mgm. glucose oxidase) and water to a final volume of 5 ml. were incubated with and without 60 μmoles of semicarbazide for 1 hr. at 37° C. in an atmosphere of air. The reaction was terminated by addition of 15 ml. of 6·67 per cent trichloracetic acid. After removal of protein by centrifugation, aliquots of supernatant were assayed for 4-aminoantipyrine as described in a previous paper (ref. 1).

* Semicarbazide added at end of incubation period just before addition of acid.

Previous studies[5] have shown that hydroxylation of aromatic rings and cleavage of ethers can be brought about by a model system consisting of ascorbic acid, oxygen and inorganic iron chelated with ethylenediaminetetracetic acid. Evidence was adduced that the actual oxidant may be an unstable complex of hydrogen peroxide with the chelated iron. Since the methæmoglobin protein system also forms a hydrogen peroxide complex[6], it is possible that a hydrogen peroxide complex is also involved in the dealkylation of the alkylamines. Studies on the action of both types of model systems on other oxidative pathways of drug metabolism are being continued.

The material in this communication has appeared in a thesis by James V. Dingell in partial fulfilment of the requirements for the degree of master of science in the Department of Chemistry, Georgetown University, Washington, D.C.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Determination of Orbital Characteristics of an Earth Satellite from Single-Station Radio-Transit Observations

MERIDIAN transit radio observations have been made of the Satellite 1958α by means of a modified Minitrack Mark II interferometer located at the Sohio Research Laboratories east of Cleveland, Ohio (lat. 41° 26·3′ N., long. 81° 32′ W.). Because of the generally low altitude of the satellite at this station, the horizontal dipoles were replaced with commercial Yagi antennas, following a suggestion of G. W. Swenson, jun., of the University of Illinois. The completed system acts as a compound interferometer in that two pairs of Yagis are separated by 2·5 wave-lengths from each other and 55 wave-lengths from the other two pairs. This was done to minimize lobe ambiguities. The antenna system deviates about 0·3 deg. from the true east–west base-line as determined by solar transit observations. The receiving system consists of a low-noise preamplifier, triple-conversion receiver, *WWV* time-marking circuit and a dual-channel recorder which was kindly loaned by the Brush Instrument Co. More than 120 transits have been observed to date. Fifty-six transits between Feb. 15 and Feb. 27 were selected for further analysis, as the multiple interferometer was in operation during that time.

The time between successive meridian passages (the synodic period) was found to give a considerable amount of information on the orbital characteristics of the satellite. In the interval between the sidereal and synodic periods the satellite covers about 30 deg. of arc in its orbit. The time to cover a given arc depends on the orbital angular velocity, which is a function of the period, eccentricity and true anomaly. The length of the arc depends on the time interval, the longitude of the node and the inclination. Values for the period, ρ; R.A. of ascending node, Ω; argument of perigee, ω; eccentricity e and inclination i at epoch (Feb. 1, 0358 U.T.) were adopted from *Harvard Announcement Card* 1393. The inclination was afterwards found to require correction. The instantaneous values of ρ, Ω and ω at the time of observation depend on the time-rate of change of the period, the regression of the node and the advance of the line of apsides respectively. The 56 transits gave 43 observed values of the synodic period. These were compared with values of the corresponding synodic periods computed on an *IBM* 650 for various values of $\dot{\rho}$, $\dot{\Omega}$, $\dot{\omega}$ and $\dot{i}$. The change in the eccentricity had a minor effect on the angular velocity in the time-interval considered, and a mean value was used.

The following values were adopted on the basis of minimizing the sums of squares of the residuals:

$$\dot{\rho} = -0{\cdot}0209 \pm 0{\cdot}0007 \text{ min./day}$$
$$\dot{\Omega} = -4{\cdot}242 \pm 0{\cdot}025 \text{ deg./day}$$
$$\dot{\omega} = +6{\cdot}255 \pm 0{\cdot}018 \text{ deg./day}$$
$$\dot{i} = 32{\cdot}08 \pm 0{\cdot}18 \text{ deg.}$$
$$\sqrt{\sum_i \frac{(O-C)_i^2}{n}} = 0{\cdot}18 \text{ min.}$$

The 'errors' or lack of fit refer to the change in the parameter necessary to change $\Sigma(O-C)^2$ by 0·01 min.^{2}, while keeping the other three parameters constant. The rate of change in period implies that the lifetime of the satellite will be of the order of two years.

The observed and computed synodic periods are plotted against the mid-point in Eastern Standard Time (E.S.T.) of the observation in Fig. 1. As 23 periods are only slightly less than two days, observations separated by this interval may be closely compared. The major change in the orbit during that time is due to the regression of the node. This causes the synodic periods west of the north point of the orbit (earlier in the day) to become shorter because of the shortening length of arc in the orbit. Correspondingly, periods east of the north point will lengthen because of the increasing orbital length of arc. Periods near the north point will be changed only slightly. On Feb. 15, the north point crossed the meridian at about 1530 E.S.T., shifting to about 1130 E.S.T. by Feb. 27 due to the regression of the node. Clearly some systematic residuals remain; a further analysis is planned to improve the parameters. The accuracy of the present results cannot compare with those determined from many Minitrack stations, at which direction cosines of the satellite itself are found. What is of interest is the information attainable from meridian observations at a single station.

A detailed account of the observations and interpretation will be published elsewhere. The project was under the direction of A. L. Jones. The design of the system and recording of the observations were due to R. W. Burhans, P. S. Fay, Warren Jackson and many others of the Sohio Research Staff. Interpretation of the data was carried out by Gordon Grant. David Frazier was in charge of the *IBM* 650

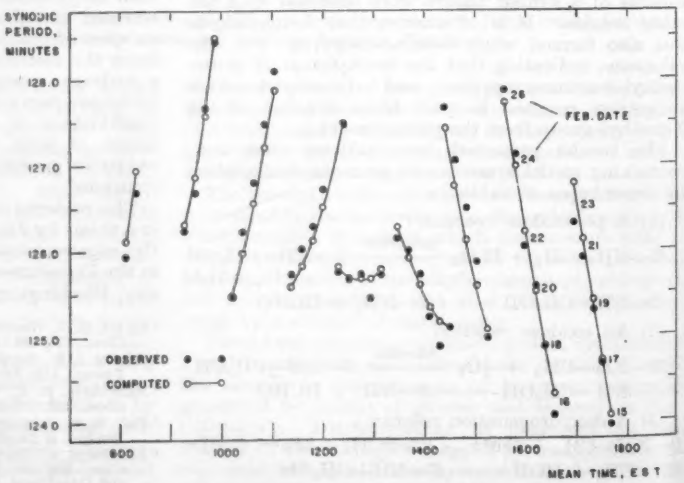

Fig. 1

computations. Special acknowledgment is due to the Standard Oil Co. of Ohio for supporting this spare-time activity.

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Electron Micrographs of Monolayers of Stearic Acid

AT the second International Congress of Surface Activity held in London during April 1957, we presented results of a study with film balance and electron microscope of monolayers of *n*-hexatriacontanoic acid[1]. This compound shows small islands irregular in size and shape at low surface pressures (15 dynes/cm.), a continuous monolayer with discontinuous uncovered areas at intermediate pressures (25 dynes/cm.), a continuous homogeneous monolayer at high pressures (40 dynes/cm.), and long flat structures two molecules thick after collapse.

Monolayers of other compounds have since been examined: stearic, arachidic, *n*-hexacosanoic and *n*-dotetracontanoic acids give, as expected, monolayer structures much like those of *n*-hexatriacontanoic acid; *n*-octadecyl alcohol and cholesterol show related structures. Of principal interest is the behaviour of stearic acid at low surface pressures. It is the classical compound in monolayer research; but because of the small thickness of its monolayer it is more difficult to study in the electron microscope than *n*-hexatriacontanoic acid.

Monolayers of stearic acid were successfully transferred from the film balance at surface pressures as low[2] as 3 dynes per cm. An electron micrograph of such a sample is shown in Fig. 1. The direction of shadow-casting is indicated by an arrow; shadows appear as light areas. Many small islands, irregular in shape and about 1000 A. in diameter, are observed. Shadow widths establish that the islands are about 25 A. or one molecule thick. Close examination reveals that the spaces between islands actually contain many small structures. Presumably, smaller aggregates and individual molecules beyond the limit of the electron microscope may also be present.

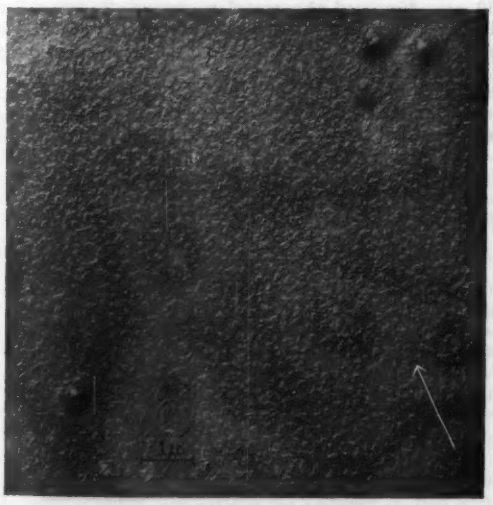

Fig. 1. Monolayer of stearic acid at 3 dynes per cm.

Fig. 2. Monolayer of stearic acid at 10 dynes per cm.

At greater surface pressures, less area remains uncovered. Fig. 2 is an unusual micrograph of a stearic acid monolayer transferred from the film balance at 10 dynes per cm. Most striking is the circular geometry of many of the islands, diameters of which range from 3000 to 50,000 A. In related monolayer studies, approximately circular islands, circular holes, and circular platelets on top of monolayers have been observed.

Circular islands that resemble flattened liquid droplets are somewhat surprising when one considers that the melting point of stearic acid is 69° C. and that the experiments were conducted at 25° C. However, forces at an edge of a 'two-dimensional' monolayer may be analogous to forces in the surface of a 'three-dimensional' system. Just as spheres with minimum surface energy appear in bulk liquid systems, circular disks may be expected in monolayers with sufficient mobility. Possible effects of droplets forming in the water film sandwiched temporarily between the monolayer and the collodion support used in transfer must also be considered; new transfer techniques now under study may resolve such effects. Experiments at higher temperatures should help define the role of surface mobility in the formation of monolayer islands.

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Effect of Hydrogen on the Deformation Characteristics of Alpha-Titanium

It is well known that when iodide titanium containing more than 10 p.p.m. by weight of hydrogen is slowly cooled from 300° C. to room temperature, a second phase, titanium hydride, is precipitated in the alpha-titanium matrix.

X-ray and microscopical studies on single crystals have revealed that the precipitate is in the form of platelets, which lie mainly along the {10$\bar{1}$0} slip planes. It is therefore natural to associate the precipitation with dislocations on the {10$\bar{1}$0} system, especially as preferential precipitation occurs in regions of high plastic strain. If it is assumed that a {10$\bar{1}$0} dislocation can dissociate as postulated by Churchman[1], the stacking fault structure associated with this dissociation requires only small additional movements of the titanium atoms to arrange these as the titanium atoms in either of the published structures for titanium hydride[2–5].

Evidence that hydrogen atoms do segregate around dislocations is provided by the observation of a very rapid strain ageing phenomenon in titanium during tensile experiments at 250° C. Calculations reveal that of the common impurities only hydrogen could diffuse at a fast enough rate to explain this effect. Experiments were carried out on both single crystals and polycrystalline titanium, which had previously been hydrogenated, the oxygen and nitrogen content being less than 0·01 weight per cent.

Little or no strain age-hardening was observed, and the work-hardening was of a parabolic nature with no significant increase in flow stress due to the presence of hydrogen. This differentiates the present deformation characteristics from those caused by 0·1 weight per cent oxygen plus nitrogen, where there is a very low linear rate of work hardening with an increased flow stress[6]. This difference suggests there is some fairly weak barrier to dislocation movement in titanium containing only low amounts of oxygen and nitrogen. Examination of the possible dislocations in the hexagonal lattice shows that two dissociated {10$\bar{1}$0} dislocations on intersecting planes can combine to form a stable barrier of the Cottrell–Lomer type[7,8], which could hinder subsequent slip.

Embrittlement under impact-testing conditions occurs by the propagation of cracks which are associated with the hydride platelets. These cracks are caused by interference of the hydride phase with subsequent slip and twinning processes.

The above results will shortly be published in greater detail elsewhere.

I wish to thank Dr. A. T. Churchman for his encouragement and many valuable discussions.

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Occurrence of Beryllium Oxide in Polycrystalline Beryllium

Sloman[1] has claimed to have found, using optical microscopy in conjunction with chemical analysis, that a beryllium oxide/beryllium eutectic forms at grain boundaries in vacuum-cast beryllium containing 0·3 per cent oxide by weight. By contrast, other workers[2] have since been unable to detect such oxide, either in the grain boundaries or present as inclusions in metal of comparable purity. It is still generally agreed, however, that the brittleness of beryllium is probably associated with some impurity, and our current results support the original claims by Sloman.

Our beryllium specimens were fabricated from electrolytic flake beryllium which had been vacuum-cast (~ 1,400° C.). The ingots were extruded at about 1,000° C. to form both rod and tube of about 1 in. diameter and by analysis were found to contain approximately 0·25 per cent beryllium oxide by weight. Our electron-diffraction study shows that specimens prepared from four different batches of such beryllium contain variable amounts of the oxide, which is probably concentrated at grain boundaries: it is clearly in the form of relatively large crystals (greater than 500 A. in diameter). It has been shown[3] that beryllium oxide is crystalline when formed or heated at temperatures above about 280° C., and develops as relatively large crystals (greater than about 500 A. in diameter) when the metal is heated in air above 600° C. for half an hour or more. The beryllium oxide in the present case must therefore have been formed at, or subjected to, temperatures in excess of 600° C., probably above 800° C., during the electrolytic preparation, vacuum casting or extrusion.

The beryllium oxide is distributed throughout the material, as the following example shows. A 1-in. rod was turned down to 1 cm. diameter, and flat surfaces of transverse and longitudinal sections were prepared by grinding, followed by abrasion on emery papers down to grade 0000, then on fine (3μ) diamond powder. The final distorted surface layer was removed by electropolishing[4], which further smoothed the surface and showed the grain size to be about 40μ. Etching the surface in 10 per cent aqueous sulphuric acid for 30 sec. dissolved the metal preferentially at about 100 A. thickness per sec., but a beryllium oxide surface produced by heating another such sample of the metal in air (for example, at 400° C. for half an hour) was passive in the solution. Fig. 1, obtained by electron diffraction after etching the metal, shows arcs due to the beryllium (which we found has a

Fig. 1

pronounced <210> fibre texture with the orientation axis parallel to the rod axis), and in addition strong sharp rings indicating randomly orientated beryllium oxide crystals of at least 500 A. in diameter. Such oxide was found repeatedly after re-surfacing in the manner described.

When preparing single-crystal surfaces in this way, clear Kikuchi-line and spot patterns were obtained with no sign of sharp diffractions from oxide. Thus the oxide observed on the polycrystalline surface was not produced as a result of the method of surfacing. Clearly, therefore, in the case of the hot-extruded material described above, the preferential solution of the beryllium by the etchant must have left the oxide crystals projecting above the metal, thus increasing their relative contribution to the diffraction pattern.

Further investigations, particularly of the penetration of oxygen into beryllium at high temperatures and the existence of oxide films in coarse and fine-grain vacuum-cast metal, are in progress.

We wish to thank Mr. G. C. Ellis and Dr. A. Moore for the provision of specimens and for helpful discussions. One of us (V. D. Scott) is on detached duty from the Atomic Weapons Research Establishment, Aldermaston; we are indebted to the Director of this Establishment for permission to publish these results.

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Kinetics of the Trigonal-to-Cubic Transition in Crystals of Cæsium Nitrate on Muscovite

It is well known[1] that the epitaxial orientation of cubic cæsium nitrate on muscovite is

$CsNO_3$ (100) [010] = muscovite (001) [010]

whereas the orientation of trigonal cæsium nitrate is

$CsNO_3$ (11$\bar{2}$1) [10$\bar{1}$0] = muscovite (001) [010], [130] and [1$\bar{3}$0]

From a general point of view, the possibility of obtaining definite orientations on definite crystallographic planes means that, of the many possible arrangements, there are some for which nucleation is more probable. In the language of statistical thermodynamics, this probability is $p = \exp\left(-\frac{\Delta F}{kT}\right)$. Consequently nucleation which gives rise to epitaxial crystals corresponds to a value of ΔF less than that for other possible arrangements. The interface between epitaxial crystals and the substrate crystal presents a smaller discontinuity than any other possible arrangement. In other words, this smaller discontinuity corresponds to both a smaller interfacial free energy and a smaller elastic strain energy.

Any polymorphic transformation undergone by the oriented crystals will involve an increase in this free energy. A shift of the equilibrium temperature, with respect to that of non-epitaxial crystals, may be foreseen. If the transformation takes place between phases of which only one is epitaxial, the shift will be large. If both phases are epitaxial, the shift will be in general smaller, and its direction will indicate the more stable epitaxy.

We have made simultaneous observations of the kinetics of the polymorphic transformation of cæsium nitrate from trigonal to cubic, on crystals of the same size obtained by evaporation of the same solution, (i) on a glass substrate and (ii) on a crystalline substrate (muscovite), in order to correlate the two processes. The two supports were placed in a Weigand heating apparatus[2] fitted to a Leitz microscope, so that the crystals oriented on the mica and the non-oriented crystals on the glass were in view simultaneously. The temperature of transformation was clearly defined by the disappearance (or appearance) of birefringence on heating (or cooling) uniformly (2 deg. C. per min. at first). We have established, in many experiments, that on heating, the birefringence appears first in the crystals on the glass substrate, and on cooling it appears later. The interval between the appearance of the birefringence in the two cases has never been more than 45 sec.

The difference in behaviour described above is quite small in comparison with that observed in other experiments. For example, for the transformation $NaBr \rightarrow NaBr.2H_2O$, in which only one phase (NaBr) is epitaxial on galena, the time difference with respect to sodium bromide unoriented on glass is almost two hours. In this case the hydration brings about an appreciable increase of the interfacial discontinuity. In the case of cæsium nitrate, however, the interfacial discontinuity varies little from one phase to the other. The direction of the variation indicates that the epitaxy of the trigonal phase is more stable and more probable.

We have recently shown[3] that the preponderant factor in determining the interfacial discontinuity is the amount of difference in symmetry. For cæsium nitrate, the change in the dissymmetry is almost negligible and shift in equilibrium is minimal.

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An Electronic Mechanism of Addition Reactions

A recent communication from Mr. Lakhbir Singh[1] seems to require a reply based rather more firmly on conventional theoretical chemistry. He refers to the decrease in reactivity of acetylene compared to ethylene, and implies that this shows that an increase in the number of π-bonds leads consequently to a decrease in reactivity. Duchesne[2] has, however, pointed out that the greater reactivity of ethylene compared to acetylene is due to the fact that the torsional oscillations in ethylene uncouple the π-electrons, whereas this cannot happen in acetylene. Singh also describes allene as "very much strained". It is difficult to see why this should be so, unless reliance is placed on the Baeyer[3] strain theory. In modern terms the central atom may be described as having two σ-bonds in an *sp*-hybrid, with two *p*-orbitals available to form two π-bonds, the planes

of which are at right-angles to each other. The low reactivity in cumulenes compared to polyenes can be attributed to the small effect of torsional oscillations on the environment of the central atoms.

Mr. Lakhbir Singh's arguments concerning the effect of electron-attracting and repelling groups can easily be replaced by the usual arguments involving hyperconjugation, and there is no need to postulate that the σ-electrons are all-important. If in addition reactions the attack is on the σ-electrons, it is difficult to see why there is any difference in reactivity between unsaturated and saturated compounds. In these and in benzene derivatives, Mr. Lakhbir Singh does not apparently distinguish between inductive and electromeric effects.

In his explanation, Mr. Lakhbir Singh apparently ignores the fundamental principle that the total electronic wave function must have the symmetry of the nuclear framework. His *p*-orbitals inclined at an angle are certainly not in accordance with this principle. He also suggests that "the distortion of the σ-electron orbits would be unsteady and non-uniform". This view seems to ignore the principle of stationary states.

It may well be, as he remarks, that the "quantum mechanical approach has not succeeded in solving this problem", but any explanation must not be contrary to the fundamental principles of quantum mechanics.

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The Pigment of *Micrococcus lysodeikticus*

While culturing cells of *Micrococcus lysodeikticus*[1], white cells, resistant to lysozyme, were often produced in liquid media containing relatively high carbohydrate. Resistant cells remained Gram-positive and were not lysed by lysozyme in the presence of ethylenediaminetetraacetic acid[2]. Optimal concentrations of cultural sodium chloride for growth improved the yellow colour of the organisms[3]. These observations suggested a relationship of the yellow pigment to the polysaccharide substrate of lysozyme.

Extraction of the pigment directly from dried organisms[1] with petroleum ether (b.p. 40–60° C.) provided a lipid extract and poor pigment yield. The pigment failed to migrate on MgO–'Celite' (1 : 1) and disappeared rapidly from this adsorbent. The following method, however, gave good quantities of pigment. *M. lysodeikticus* was grown at 28° C. in 250-ml. shake flasks, each containing 100 ml. medium[3]. After 48 hr., cells were centrifuged and washed with 0·85 per cent saline. The equivalent of 4·2 gm. cell dry weight was used in a typical experiment. Cells were suspended in 50 ml. 0·85 per cent saline and 150 ml. *M*/15 phosphate buffer, *p*H 6·3. 40 mgm. Armour egg white lysozyme were added and lysis was carried out for 1 hr. with occasional shaking; 400 ml. cold acetone were added. Extraction was continued for 48 hr. (5° C.) with frequent shaking. The clear yellow supernatant was decanted and filtered by gravity (Whatman No. 1). Extraction was repeated with acetone. The second extract was more highly coloured. This was combined with the first fraction and evaporated to dryness in a stream of air at 25° C. The residue was extracted with 100 ml. petroleum ether, concentrated to 3 ml. (25° C.) and transferred to a 1 cm. × 12 cm. activated calcium carbonate column. (The non-extractable residue contained a yellow-orange pigment which was also insoluble in carbon disulphide but soluble in water. This has not been studied further.) The eluant was petroleum ether. Two yellow bands migrated on the calcium carbonate column[4], a fast-moving component, *A* (distribution coef. is about 1·9) and a low-moving component, *B* (distribution coef. is about 2·7). The distribution coefficient was calculated as K = vol. of eluant flowed into column ÷ fraction of column-length migrated by the band × gm. of adsorbent. Band *A* was eluted with petroleum ether. Band *B* was obtained by extruding the column and extracting the yellow segment overnight with absolute ethanol at 5° C.

Table 1. Visible Spectra of Fractions *A* and *B* in Various Organic Solvents

Fraction	Solvent	$E_{max.}$ (mμ)			
A	Petroleum ether (b.p., 40–60° C.)	468	440	414	(329)
B	,,	470	440	410	
A	Carbon disulphide	494	462	440	375
B	,,	490	460	378	
A	Calcium carbonate	477	447	423	
B	,,	470–80	440–50		

Characteristic $E_{max.}$ for the carotenoids are shown in Table 1. Although we have not seen reports concerning the pigments of *M. lysodeikticus*, Sobin and Stahly[4] have isolated carotenoids from several other species. Those species which have two yellow carotenoid alcohols similar to the pigments from *M. lysodeikticus* are *Sarcina lutea* and *M. flavus*. These pigments are dissimilar from a carotenoid from *M. aquivivus*, *M. maripuniceus* and *M. infimus*[5].

This investigation was supported in part by a Research Grant (*E*–1119 *C*), National Institute of Allergy and Infectious Diseases, National Institutes of Health, Public Health Service.

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Bacterial Oxidation of Lactose and Melibiose

During an investigation of bacteria isolated from blocks of whale meat, two distinct strains of paracolon bacteria (*B1x*, urease-positive; and *C6*, urease-negative) were obtained, the sugar metabolism of which was interesting. Tested in the normal way with Durham tubes, these organisms produced acid from lactose within 5–12 days at 30° C. and were accordingly recorded as late lactose fermenters. Tested by Hugh and Leifson's[1] method, both strains fermented cellobiose, maltose, sucrose, trehalose, galactose, glucose, mannitol and sorbitol, producing acid and gas anaerobically within 48 hr. at 30° C.

Lactose, melibiose and glycerol, however, were not fermented but oxidized, that is, acid was produced from these sugars within 48 hr. under aerobic conditions only.

In shaken, aerobic cultures at 30° C. of strain *B1x*, containing 2 per cent (w/v) of lactose or melibiose, all reducing power disappeared within 48 hr. Paper chromatograms of culture filtrates, using *n*-propanol/ammonia (70 : 30) as solvent and sprayed with ammoniacal silver nitrate or thymol blue, showed respectively spots corresponding to lactobionic acid and melibionic acid (prepared by the method of Levene and Jorpes[2]), which were absent from control cultures without sugar. Comparison of the sizes of the spots with those of known concentrations of the acids suggested that the conversion of sugar to acid had, in each case, been nearly quantitative.

Confirmatory evidence of the identity of the acids was obtained by subjecting the filtrates, after passage over 'Zeo-Karb 225', to hydrolysis with *N* hydrochloric acid at 100° C. for 2 hr., removing the acid with silver oxide and running the resultant solutions on paper using the same solvent. On spraying with ammoniacal silver nitrate, spots corresponding to galactose and gluconic acid, absent from the original filtrates, were obtained. The acids present in the original culture filtrates have therefore been provisionally identified as lactobionic and melibionic.

It seems that this paracolon strain is able to oxidize lactose and melibiose to lactobionic and melibionic acids respectively. The oxidation of lactose by paracolon bacteria[1], and the oxidation of lactose and maltose to the corresponding acids by oxidative *Pseudomonas*[3,4] and *Achromobacter*[5] spp. have been reported, but so far as is known, this is the first recorded instance of the production of melibionic acid from melibiose. The wider use of the Hugh and Leifson technique would probably reveal more cases of this kind. This work emphasizes the inadequacy of the traditional fermentation tube technique in which both aerobic and anaerobic conditions exist.

I wish to thank Dr. F. A. Isherwood and Mr. F. C. Barrett for their help and advice.

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Role of Oxygen in the Formation of α-Amino-butyric Acid by a Staphylococcus

The formation of α-amino-butyric acid by animal cells has been studied[1,2], but little is known of the method of its formation by staphylococci[3].

It has been shown here, using shaken flasks, that the formation of α-amino-butyric acid by staphylococci is a function of the amount of oxygen available to the culture. It has been confirmed that the acid can be derived from threonine and it has been shown that, presumably by a similar process, alanine can be formed from serine.

The organism used was the *V8* strain of staphylococcus employed by Gladstone and van Heyningen[4]. The culture medium, consisting of 'Bacto Casamino-acids', 2 per cent; yeast diffusate, 20 per cent; sodium lactate, 0·75 per cent; sodium glycerophosphate, 2 per cent; and mineral salts was the same as that used by Gladstone and van Heyningen. The organisms were grown at 37° C. in 500-ml. conical flasks plugged with cotton wool, the oxygen solution-rate being varied by varying the volume of medium in the flask. When shaken on the bottom shelf of a Kantorowicz[5] shaker the flask containing 1/5 its volume of liquid gave an oxygen solution-rate determined by sulphite oxidation[6] of 29 m.moles O_2/l./hr. and the flask containing 1/20 its volume of liquid gave a value of 75 m.moles O_2/l./hr.

Changes in amino-acid composition of the medium during growth were followed by two-way chromatography.

While no new amino-acids appeared during growth in the flasks containing 1/20 their volume of medium, a fresh acid appeared early in the logarithmic growth-phase in the flasks containing 1/5 their volume of medium. This was shown to be α-amino-butyric acid.

Cells from flasks with the lower oxygen solution-rate incubated with threonine formed α-amino-butyric acid; with serine, alanine was formed, while with aspartic acid, glutamic acid or methionine, no new material appeared. Cells from flasks with the higher oxygen solution-rate similarly treated produced no changes.

When nitrogen was substituted for air in sealed flasks with 1/20 vol. medium, α-amino-butyric acid was formed during growth. When both sodium lactate and sodium glycerophosphate were omitted from the medium, the staphylococci still grew well. It was shown that growth in such a medium in the flasks containing 1/5 vol. medium failed to produce α-amino-butyric acid, whereas with lactate and glycerophosphate present it was formed. Replacement of air by nitrogen when lactate and glycerophosphate were absent from the flasks containing 1/5 vol. medium brought about formation of α-amino-butyric acid.

When glucose or glycerol was substituted for lactate and glycerophosphate on an equimolar basis, α-amino-butyric acid was still formed during growth in flasks containing 1/5 vol. medium. The use of pyruvic acid, malic acid, formic acid, succinic acid or α-keto-glutaric acid as a substitute for lactate and glycerophosphate failed to bring about α-amino-butyric acid formation. Addition of pyruvic acid to the lactate-containing medium in the flasks with the lower oxygen solution-rates suppressed the formation of α-amino-butyric acid.

It would seem from these results that the formation of α-amino-butyric acid by this staphylococcus is due to the use of threonine as a hydrogen acceptor under conditions of low oxygen supply, serine presumably functioning in a similar manner.

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An Alternative Pathway for the Degradation of Cholic Acid by Micro-organisms

Since the publication of the first report[1] on the microbiological degradation of cholic acid (I) to 7α-hydroxy-3 : 12-dioxo-Δ^4-*bis*-norcholenic acid (VII) by *Streptomyces gelaticus* 1164, additional investigations have been continued and two possible pathways[2] for cholic acid degradation have been proposed.

S. gelaticus 1164 can grow on a medium containing the *bis*-nor acid (VII) as the sole source of carbon. On the other hand, *Streptomyces rubescens*[3] is able to utilize cholic acid as the sole source of carbon as well as *S. gelaticus* 1164, but is unable to utilize this *bis*-nor acid.

Though interpretation of such experiments is not simple, we suggest that cholic acid degradation by *S. rubescens* proceeds through an alternative pathway different from that found with *S. gelaticus* 1164.

Recently, it was found[4] that *S. rubescens*, cultured in a medium containing cholic acid as the sole source of carbon, produced various intermediates such as 7α : 12α-dihydroxy-3-oxo-Δ^4-cholenic acid (III), 7α-hydroxy-3 : 12-dioxo-Δ^4-cholenic acid (IV), 12α-hydroxy-3-oxo-$\Delta^{4,6}$-choladienic acid (V), 3 : 12-dioxo-$\Delta^{4,6}$-choladienic acid (VI) and some unidentified compounds different from the *bis*-nor acid (VII).

Considering the structures of these intermediates, an oxidative pathway of cholic acid by *S. rubescens* may be deduced as follows (Fig. 1), though the acid II has not yet been isolated.

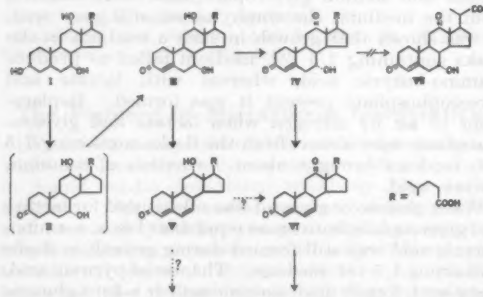

Fig. 1

S. rubescens cultures in a cholate medium give a light absorption peak at 246 mμ at the earlier incubation period, and a parallelism between an increase of the optical density and the incubation period is observed. After the optical density at 246 mμ reaches its maximum, it decreases in parallel with continuation of the incubation, and, simultaneously, a new peak at 290 mμ appears ; finally, both the peaks at 246 and 290 mμ disappear at an almost equal rate at the end of the incubation period.

These findings may be interpreted as follows : an appearance of a peak at 246 mμ in the cholate culture begins with the conversions I → II → III → IV ; a decrease of the optical density at 246 mμ and an appearance of a peak at 290 mμ are due to the conversion III → V or IV → VI ; and further degradation of V or VI accelerates the conversion III → V or IV → VI. This process will finally lead to the disappearance of both the peaks at 246 and 290 mμ.

Much of the representation of our proposed pathway for cholic acid degradation by *S. rubescens* is still largely hypothetical. However, the isolation and identification of the acids V and VI in this experiment demonstrate for the first time a microbiological introduction of the $\Delta^{4,6}$-3-ketone structure into the cholane nucleus of cholic acid.

Further study on the proposed pathway is in progress and will be reported in detail elsewhere.

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Uridine Diphosphate Amino-sugar Compounds from *Staphylococcus aureus* inhibited by Penicillin

In 1952, Park[1] showed that three uridine diphosphate amino-sugar compounds were accumulated in *Staphylococcus aureus* inhibited by penicillin. Compound I contained no amino-acid residue. Compound II contained one alanine residue and compound III contained a peptide which was composed of one glutamic acid, one lysine and three alanine residues. Recently, Strominger indicated that, even though in much smaller amount, these compounds are contained also in normal cells[2], and that the amino-sugar component is 3-O-carboxyethyl glucosamine[3], which is known as one of the main components of cell walls[4].

We have found a variety of similar uridine diphosphate amino-sugar compounds, some of which contained aspartic acid and glycine. Cells of *S. aureus* strain 209 *P* treated with penicillin were extracted with trichloracetic acid. After removal of trichloracetic acid, barium hydroxide and sufficient sodium hydroxide were added to the extract to adjust the *p*H to 9, and the precipitate was removed. To the concentrated supernatant, ethanol was added to 50 per cent by volume and the precipitate was separated. More ethanol was added to the supernatant to make it 90 per cent and the precipitate was separated. Each precipitate was fractionated by ion exchange chromatography with 'Dowex 1' in the chloride form. The fractions with the same peak of optical density at 260 mμ were pooled, concentrated by adsorption on 'Norit' and subsequent elution with ammoniacal ethanol, and were analysed for components. After hydrolysis with 6 *N* hydrochloric acid at 120° for 6 hr. in a sealed tube, amino-acids were separated and estimated by two-dimensional paper chromatography with butanol/acetic acid/water (4 : 1 : 5) and phenol/*m*-cresol/borate buffer *p*H 9·3 (25 : 25 : 7) as solvent systems[5]. The result of paper chromatography on fractions containing appreciable amounts of all the three components, uridine, N-acetyl-amino-sugar and amino-

Table 1. Amino-acid Detection by Paper Chromatography

Preparation	Fraction No.*	Elution medium	Alanine	Lysine	Glutamic acid	Aspartic acid	Glycine
Precipitated at 0–50 per cent ethanol	1	0·01 *N* HCl / 0·01 *N* NaCl	−	++	++++	+++	++++
	2	0·01 *N* HCl / 0·01 *N* NaCl	−	++	++	−	++++
	3	0·01 *N* HCl / 0·01 *N* NaCl	++	+	++	+	+
	4	0·01 *N* HCl / 0·01 *N* NaCl	+++	++	+	−	−
	5	0·01 *N* HCl / 0·05 *N* NaCl	−	+	+	+	+
	6	0·01 *N* HCl / 0·1 *N* NaCl	+	+	+	−	−
	7	1·0 *N* HCl	++	++++	++	−	trace
Precipitated at 50–90 per cent ethanol	1	0·01 *N* HCl / 0·01 *N* NaCl	+	+	+	−	−
	2	0·01 *N* HCl / 0·05 *N* NaCl	−	+	+	−	−
	3	0·01 *N* HCl / 0·1 *N* NaCl	+	trace	trace	−	−

* This represents peak and shoulder of absorption at 260 mμ. They were analysed for nucleoside components, N-acetyl-amino-sugar and amino-acid components, and the only fractions containing all three components in appreciable amounts have been included.

acids, is shown in Table 1; the amounts of samples were adjusted to give about the same amino-sugar content. When normal cells were treated similarly, much smaller amounts of amino-acid-containing uridine derivatives were obtained, in which the same species of amino-acid residues were detected as in the case of the penicillin-treated cells.

The result suggests that there may be a number of compounds containing some of the five amino-acids in various combinations. Further attempts to separate each fraction into components are in progress. In connexion with the present results, it is to be noted that alanine, lysine and glutamic acid have been found in cell walls of Gram-positive micro-organisms as the main components[3,4,6], whereas glycine has been discovered in cell walls of *Staphylococci*[4] and aspartic acid in cell walls of *Lactobacilli*[4]. This is additional evidence for Stromingen's hypothesis[3] that these uridine diphosphate amino-sugar compounds are possible precursors of cell walls.

Further details of this work will be reported elsewhere.

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An Antibiotic produced by a *Bacillus* sp., active against *Haemophilus pertussis*

A strain of *Bacillus* (probably *B. subtilis*) has been found to produce an antibiotic effective against *H. pertussis* and *Neisseria* spp. The antibiotic spectrum is somewhat unusual, and although attempts at purification achieved little, the following is a summary of the results[1].

The antibiotic is produced in highest concentration (titre 1 in 128 against *N. meningitidis*) in aerated culture at 22° in a medium containing horse-meat and potato extracts. Growth in a synthetic medium based on that of Hills *et al.*[2] yielded an antibiotic of different properties; this material was not further investigated. The antibiotic was extracted from the enriched medium by extraction with *n*-butanol at *p*H 4·5. Removal of the butanol and extraction with *n*-hexane yielded an amorphous brown powder (petrin) containing most of the activity (titre 1 in 125,000 against *N. meningitidis*).

Extraction of petrin with a number of organic solvents yielded several fractions, all with the same activity, and with the same composition as determined chromatographically.

Paper chromatography of petrin, using a chloroform/*n*-butanol/water (46 : 4 : 50) solvent mixture, indicated the presence of at least three fractions: (*a*) antibiotic, (*b*) hæmolytic, (*c*) fluorescent in ultra-violet light. Active material could not readily be extracted from the paper.

Emulsion formation precluded the use of a Craig countercurrent extraction apparatus, but by repeated centrifugation a ten-tube distribution was accomplished. The principal antibiotic-containing fraction did not contain nitrogen. A smaller antibiotic-containing fraction did contain nitrogen.

The *LD*50 for 20-gm. mice injected intraperitoneally was 5 mgm.

A summary of the antibiotic spectrum of petrin is given in Table 1.

Table 1. Antibiotic Spectrum of Petrin

Organism	Dilution of antibiotic for growth at	Dilution of antibiotic for inhibition at
N. meningitidis	150,000	125,000
N. gonorrhoeae	75,000	50,000
N. catarrhalis	5,000	1,000
H. pertussis	125,000	100,000
H. influenzae	50,000	25,000
H. parapertussis	100,000	50,000
C. diphtheriae	25,000	5,000

No inhibition at 1/200 of *E. coli*, *A. aerogenes*, *Sh. sonnei*, *Sh. flexneri*, *Salm. typhi*, *Ps. pyocyanea*, *Prot. vulgaris*, *Kleb. pneumoniae*, *Staph. albus*, *Staph. aureus*, *Clostridium* spp., *Candida albicans*, *Aspergillus niger*, *Penicillium notatum*.

The physical and chemical properties of petrin are: soluble in water above *p*H 4·5; stable at room temperature in the range *p*H 4·5–11; boiling at *p*H 8·0 reduced the activity by 66 per cent in 10 min., thereafter it remained constant for 50 min.; stable to pepsin and trypsin; stable to dry heat (100°); adsorbed on to charcoal but not readily eluted; partially soluble in chloroform, ethanol; insoluble in acetone, ether.

Comparison of petrin with 26 other antibiotics attributed to *B. subtilis*, and 29 antibiotics attributed to other members of the Bacillaceae, indicated that petrin has not previously been described.

My thanks are due to Prof. J. W. McLeod and Prof. C. L. Oakley for their interest and encouragement.

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Flavofungin, a New Crystalline Antifungal Antibiotic: Origin and Biological Properties

During the systematic study of actinomycetes antagonizing fungi pathogenic in man, a species of *Streptomyces* (*SA*-IX/1) was found from desert sand that markedly inhibits growth of *Cryptococcus neoformans* and *Trichophyton mentagrophytes* used for screening[1]. In laboratory deep fermentation, besides the antifungal antibiotic, an antibacterial one was produced also by this species. A natural stable variant (*SA*-IX/3) differing morphologically from the original strain isolated was selected that is capable of producing increased quantities of the antifungal and decreased quantities of the antibacterial agent. This proved to be a new species and has been named *Streptomyces flavofungini*. The antifungal, crystalline antibiotic (Fig. 1) was isolated as a uniform product from the mycelium and fermentation fluid of this asporogenic, chromogenic variant. From its colour and effects, the new antifungal agent has been called 'flavofungin'.

Pure flavofungin has no influence upon growth of *Streptomycetes* and common bacteria; but the growth of *B. subtilis* and of a few strains of *M. pyogenes* var. *aureus* is inhibited by relatively high concentrations of more than 100 μgm./ml. Marked inhibition is exerted *in vitro* upon the growth of pathogenic and non-pathogenic yeasts and yeast-like fungi, dermatophytes, and also of saprophytic and plant pathogenic fungi; inhibitory concentrations are shown in Table 1. Assays were carried out by serial dilutions in Czapek–Dox, Sabouraud, Jensen and mush media. Its diffusion into agar is rather slow.

In aqueous suspension, given *per os* or subcutaneously, in dosages up to 250 mgm./kgm., to the mouse,

Fig. 1. Flavofungin crystals

Table 1

Micro-organism	Inhibitory conc. (μgm./ml.)
Fungi	
Aspergillus clavatus	15
Penicillium chrysogenum	8
Penicillium novum hybrid	8
Penicillium sp. (two strains)	10–20
Scopulariopsis sp.	15
Cephalosporium sp.	15
Monosporium apiospermum	15
Helminthosporium sp.	10
Trichotecum roseum	15
Mastigocladium sp.	10
Yeasts and yeast-like fungi	
Candida albicans (three strains)	4–5
Candida krusei	6
Candida tropicalis	15
Saccharomyces cerevisiae (three strains)	3–20
Saccharomyces niger	2
Cryptococcus neoformans	2
Torula utilis	10
Hansenula anomala	10
Rhodotorula sp.	2
Torulopsis pulcherrima	2
Pathogenic fungi	
Trichophyton mentagrophytes	20
Trichophyton tonsurans (two strains)	8–30
Trichophyton rubrum (two strains)	10
Trichophyton gypseum (two strains)	20
Trichophyton sulfureum	8
Epidermophyton kaufmann-wolf (three strains)	15–20
Epidermophyton inguinale	10
Microsporum canis	8
Microsporum gypseum	8
Achorion quinckeanum	8
Ceratinomyces	10
Phialophora verrucosa	20
Histoplasma capsulatum	10
Sporotrichum schenkii	10
Hormodendrum compactum	8
Nocardia asteroides	20
Geotrichum sp.	20

no acute or late symptoms were evoked; *LD*50 is 25 mgm./kgm. in aqueous suspension given by the intraperitoneal route.

In the fæces of mice fed with *Candida albicans*, no colonies, or only a few, can be demonstrated after having received flavofungin *per os*, in marked contrast to untreated controls.

Flavofungin is strongly bound to serum proteins, but can be liberated.

According to its chemical, physical and biological properties, flavofungin is not identical with formerly known antifungal antibiotics[2]. Its isolation and chemical properties will be described in detail elsewhere.

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Effect of Heparin on Pathologically Decreased Serum Esterase in Carcinoma

Plasma and serum esterolytic activity may be considerably decreased in pathological conditions. The substrates most often used for the determination of esterolytic activity are acetylcholine[1], tributyrine[2] and procaine[3]. Decreased activity is found most often in cirrhosis of the liver and carcinoma. In our work ethyl butyrate was used as the substrate and esterase activity was determined by the titrimetric method[4]. The values are given in ml. of 0·05 *N* sodium hydroxide required to neutralize the acid liberated in 24 hr. In agreement with other workers we found low values, especially in some forms of carcinoma and cirrhosis. These low values are in sharp contrast to the increase in esterase activity

Table 1. Effect of Heparin on the Esterase Activity of Serum in Carcinoma

Case No.	Diagnosis	Esterase activity (ml. 0·05 *N* sodium hydroxide)	Rise of esterase activity after heparin injection (per cent)
1	Bronchiogenic carcinoma	0·42	780
2	Carcinoma of the stomach	0·44	259
3	Carcinoma of the stomach	0·78	203
4	Adenocarcinoma of the kidney	1·40	113
5	Bronchiogenic carcinoma	1·46	95
6	Bronchiogenic carcinoma	2·08	93
7	Bronchiogenic carcinoma	1·66	81
	Average in 25 controls	3·16	35

after administration of heparin. Five minutes after intravenous injection of heparin in amounts of 100 units per kgm. body-weight, the increase reached as much as 780 per cent (Table 1).

This increase is much greater than in normal persons, in whom esterase activity has an average value of 3·16 ml. 0·05 *N* sodium hydroxide[5] with a dispersion of 2·00–4·85, by our method. There is a definite increase after administration of heparin in normal persons[6], but it rarely exceeds 70 per cent and we found no increase greater than 100 per cent.

No explanation can at present be given for the great increase of the pathologically low values of esterase in carcinoma. There are, however, the following possibilities: (1) that there is an esterase inhibitor in the blood of the patients which is inactivated by heparin; (2) that heparin washes out from the tissues into the blood stream an esterase which, in carcinoma, is not, or is only partly, damaged and which is able to break down ethyl butyrate.

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Effect of a Lethal Electric Shock during Hypothermia

In our experiments we applied direct current at 220 V., or alternating current, through a resistance with which the potential could be varied between 10 and 220 V. The current passing through the animals was registered by milliammeter. Copper electrodes were attached to the forelegs of mice weighing 20–25 gm., the shaved limbs of which had been moistened by a solution of sodium chloride. The mice were cooled by Giaja's method. The temperature of the colon was registered by a thermistor thermometer.

Table 1 summarizes our results, from which it can be seen that hypothermia has a protective action. Increasing the potential enabled the hypothermic animals to withstand a higher current. We found that with a direct current hypothermic animals withstood a current lethal for controls at only 150 V.; whereas with alternating current, the lethal current was obtained at a potential of 120 V. Histological examination of the mice which were killed by the electric current revealed no essential or characteristic changes in the nervous system or in the heart.

Table 1. Effect of Electric Shock on Normal and on Hypothermic Mice

Current	Colonic temperature	Current passed through the animals (mean value)	Dead/shocked
Direct current (80 V.; 10 sec.)	37–39° C.	62 m.amp. ♂	46/50
	37–39° C.	100 m.amp. ♀	48/50
	15–20° C.	40 m.amp. ♂	1/50
	15–20° C.	56 m.amp. ♀	3/50
Alternating current (80 V.; 10 sec.)	37–39° C.	100 m.amp. ♂	50/50
	37–39° C.	118 m.amp. ♀	50/50
	15–20° C.	40 m.amp. ♂	1/50
	15–20° C.	55 m.amp. ♀	2/50

The conductivity of males under normal conditions is $7{\cdot}8 \times 10^{-4}$ ohm^{-1}; in a hypothermic state it is 5×10^{-4} ohm^{-1} (decrease, 36 per cent). The conductivity of control female mice is $12{\cdot}5 \times 10^{-4}$ ohm^{-1}, that of cooled females 7×10^{-4} ohm^{-1} (decrease, 44·1 per cent). Putting the mean temperature of mice as 20° C., the thermal coefficient of male mice is 1·86 per cent/degree, that of female mice is 2·2 per cent/degree, which corresponds very well with the thermal coefficient of ion activity. Therefore the main reason for the decrease in conductivity is probably the change of ion activity with temperature.

Full details of this work will be published in *Acta Physiol. Hungarica*.

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Effect of Muscular Activity prior to Venepuncture on the Respiration of Leucocytes *in vitro*

During an investigation of the respiration of human leucocytes we noticed that moderate exercise by the donor prior to venepuncture seemed to be associated with a high rate of leucocyte oxygen consumption. Determination of the oxygen consumption of leucocytes (resuspended in a modified Krebs No. 2 buffer) was made by the direct method in Warburg respirometers at 37° C. Results were expressed as μmoles oxygen consumed per hr. per 10^7 leucocytes, so that the effect of any variation in total white cell count was eliminated.

We therefore compared the oxygen consumption of white blood cells taken before and after exercise from six normal subjects. All were members of the clinical or laboratory staff, aged 18–29 years. The subjects were fasting, and had rested on a bed for 30 min. before the first blood sample was obtained by venepuncture. A moderate walking exercise lasting 3–4 min. was then performed. Leucocytes obtained by venepuncture 5 min. after the walking exercise showed increased oxygen consumption 36–71 per cent above the control value before exercise (Table 1). Estimations of the subjects' oxygen consumption

Table 1. Effect of Exercise on Respiration of Leucocytes *in vitro*

Subject	Estimated surface area ($m.^2$)	Before exercise: White blood cell oxygen consumption*	Before exercise: Subject's oxygen consumption†	After exercise: White blood cell oxygen consumption	After exercise: Subject's oxygen consumption	Percentage increase in oxygen consumption: White blood cells	Percentage increase in oxygen consumption: Subject
1	1·82	0·086	226	0·148	246	62	9
2	2·01	0·138	359	0·202	437	46	22
3	1·86	0·112	199	0·190	298	57	49
4	1·88	0·155	203	0·265	279	71	37
5	1·92	0·091	272	0·136	390	49	43
6	1·78	0·096	218	0·130	235	36	8

* μmoles oxygen/hr./10^7 leucocytes. † ml. oxygen/min.

(using a Benedict–Roth apparatus) confirmed that exercise had been moderate. Differential white cell counts were made before and after exercise: there was no significant alteration in the count.

The possibility that the change in leucocyte oxygen consumption was due to venepuncture was considered. Blood samples were taken from three normal subjects, with a similar time interval between samples as before, but without exercise. The change in oxygen consumption between first and second samples was − 11, + 5 and − 3 per cent.

We conclude from these results that: (1) a substance may appear in the blood as a result of moderate exercise which has the property of stimulating the metabolic rate of the leucocytes *in vitro*; (2) in previous work on respiration of leucocytes the effect of preceding muscular activity was not taken into account, and this may explain some of the discordant results reported.

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Effect of Acetylcholine on the Membrane Resistance and Threshold of Atrial Muscle Fibres

There is substantial indirect evidence that acetylcholine increases the conductance of the atrial muscle membrane probably by increasing the permeability to K^+ and Cl^- [1,2]. In addition, acetylcholine has an effect on the sodium-carrying system[3]. These two actions form the basis of a hypothesis suggested by us[3] for the possible explanation of the excitatory and inhibitory actions of acetylcholine on atria described by Burn[4].

It seemed vital to determine what effect acetylcholine had on the membrane resistance and on the threshold. We have attempted the following experimental techniques to examine this problem. (*a*) One microelectrode was used for stimulating and recording; (*b*) a double-barrelled microelectrode was used and (*c*) two microelectrodes (stimulating and recording) were inserted into the same muscle fibre. All methods proved extremely exacting. Indeed, Trautwein, Kuffler and Edwards[1] discarded methods (*a*) and (*c*) and used a method employing external electrodes which demonstrated changes in the membrane resistance and time constant. They were not able to determine changes in the threshold. In the present work method (*a*) was abandoned, method (*b*) is being further developed and method (*c*) was found to be entirely successful in only one of twenty experiments.

In view of the implications of the findings, we are reporting the results of this single experiment.

Two microelectrodes were inserted into a single muscle fibre of rabbit right atrium driven electrically at a rate of 3·6/sec., current being passed through one electrode and the resultant membrane potential changes recorded through the other. Square pulses of depolarizing current applied through the stimulating microelectrode between every eighth–ninth externally applied stimuli produced membrane changes of the form shown in Fig. 1. Acetylcholine 10^{-6} reduced the amplitude and time constant of rise of this potential.

This is interpreted as being direct evidence of a fall in membrane resistance. There was no concomitant change in membrane resting potential or maximum rate of depolarization. At the same time the threshold was decreased, that is to say, the membrane had to be depolarized to a lesser extent to initiate an extra response. A slight increase in current was required to stimulate. This was due to the fact that the decrease in threshold did not entirely compensate for the fall in membrane resistance.

The decrease in threshold could be due to a direct effect on the sodium-carrying system. Alternatively, it is conceivable that if the membrane time constant were of the same order or slightly greater than that of the inactivation of the sodium-carrying system, then a reduction in time constant of the membrane to a value lower than that of the sodium inactivation could result in a decrease in threshold.

We are endeavouring to confirm these findings with the double-barrelled microelectrode technique; but as they further support our recently suggested hypothesis[3] it does seem that in considering the

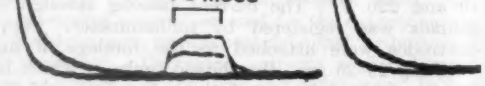

Fig. 1. This consists of two superimposed photographs, one before and one after the application of 10^{-6} acetylcholine to isolated rabbit right atrial muscle. A recording and a stimulating electrode are inserted into the same cell. The changes in membrane potential following the application of a current pulse via the stimulating electrode is shown between the eighth–ninth action potentials. The amplitude of the responses are just subthreshold (the larger is before the acetylcholine was applied). It can be seen that the acetylcholine has decreased the time constant of the membrane and decreased the threshold, the duration of the two action potentials being decreased at the same time. (Photograph retouched to correct losses in photography)

effects of acetylcholine on atrial muscle one must take into account not only its effects on membrane resistance (K^+ permeability and rate of repolarization) but also the possible direct–indirect effects on depolarization mechanisms.

This research project was supported by the Life Insurance Medical Research Fund of Australia and New Zealand.

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Sites of the Physiological Breakdown of the Red Blood Corpuscles

IF erythrocytes labelled with iron-59 in their hæmoglobin are transfused from a donor rabbit to a sister animal, and, after a lapse of some hours, the labelled iron is located in the depot iron fraction, in the ferritin and hæmosiderin of organs, we can conclude that erythrocytes were broken down in these organs.

Since the plasma contains no radioiron, the only source of iron-59 present in the depot iron fractions is radioiron liberated from the transfused labelled red corpuscles.

This line of thought induced us to replace red corpuscles contained in 20 ml. of rabbit blood with the corresponding amount of washed red blood corpuscles all labelled with iron-59 from a sister animal.

The results of one of our experiments are given in Table 1.

Table 1. DISTRIBUTION OF IRON-59 IN THE DEPOT IRON (FERRITIN + HÆMOSIDERIN) OF ORGANS

Organ	Total depot iron (mgm.)	Total radio-activity of depot iron (c./min.)	Depot iron radioactivity per gm. organ (c./min./gm.)	Percentage distributed *
Liver	10·9	9,830	154	8·4
Spleen	0·681	2,340	2,600	2·0
Red bone marrow†	5·9	86,500	2,470	74·0
Kidneys	0·850	4,300	314	3·7
Lungs	0·590	9,250	1,050	7·9
Small intestine	0·807	4,600	70	4·0

* Total radioactivity of the depot iron of all organs investigated = 100 per cent.
† The total amount of the red bone marrow was assumed to comprise 1·1 per cent of the body-weight.

It is seen that the depot iron-59 content of 1 gm. of spleen is higher than that of an equal amount of any other organ studied. Considering the total organs, however, the red bone marrow contains more iron-59 than any other organ investigated. In seven other experiments the ratio of the depot iron-59 content of the red bone marrow and the spleen varied between 6 and 50, the corresponding ratio of the red bone marrow and liver figures being 0·6–9.

In view of the fact that the spleen of the rabbit is very small, its weight being only 1/35 that of the red bone marrow, we cannot expect the ratio of the amount of erythrocytes broken down in the bone marrow and the spleen to be as high in other mammalian species as it is in the rabbit. Our results suggest, however, that even in man presumably a third or more of the number of erythrocytes terminating their physiological life-cycle is broken down in the bone marrow.

Miescher[1] published results similar to those reported here. He transfused red corpuscles labelled with chromium-51 into rabbits and found that, after a lapse of 25–35 days, about 30–75 per cent of the chromium-51 was located in the bone marrow, 23–49 per cent in the liver and 6–40 per cent in the spleen. The finding of Miescher that the spleen accumulates a larger percentage of the chromium-51 than found by us is possibly due to a large part of the chromium-51 leaking out from intact erythrocytes. A part of this chromium may accumulate in the spleen. We arrived to the same conclusion as Miescher concerning the importance of the bone marrow for the physiological breakdown of the red corpuscles. In this connexion it is of interest to recall that Mann *et al.*[2] found that the main part of the bilirubin is formed in the bone marrow.

The interest taken by Prof. G. Hevesy in this investigation is gratefully acknowledged.

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Anticholesterol Activity of α-Lipoic Acid

SINCE α-lipoic acid is known to affect lipid metabolism, we have investigated the effect of this acid on the lipid content of plasma, liver and aorta from rabbits which had been fed on a diet containing an excess of cholesterol[1]. Rabbits weighing 2·5–3 kgm. were divided into four groups, each containing five animals. Group *A*, the control group, received a diet of ordinary commercial rabbit food. Each animal in groups *B*, *C* and *D* received this diet, supplemented for seven days with 1 gm. daily of cholesterol mixed with 9 gm. of shredded carrot. Group *B* received no further treatment. Group *C* received daily intramuscular injections of α-lipoic acid (5 mgm./kgm. of the sodium salt in saline). Group *D* received the same treatment as *C*, except that the injections were not started until the day after the high cholesterol diet had been stopped. After fifteen days from the start of the experiment, the animals were killed by bleeding, and samples of blood, liver and aorta were taken aseptically and weighed. Total lipids, phospholipids and neutral lipids were determined by the method of Bloor[2], and cholesterol by the method of Schoenheimer and Sperry[3].

The results (Table 1) show that the high cholesterol diet alone (group *B*) caused a clear-cut increase in plasma total lipids and cholesterol, and a less marked increase in plasma phospholipids and neutral lipids. The liver lipids showed a similar behaviour, but here the increase was larger for cholesterol and neutral lipids than for phospholipids. The aorta cholesterol was also increased, but phospholipids and total lipids were not much changed.

Table 1. Lipid Content from Tissues from Rabbits fed on a Normal Diet (Group *A*), on a High Cholesterol Diet (Group *B*) and on a High Cholesterol Diet and treated with α-Lipoic Acid (Groups *C* and *D*)
Values are given in gm./100 gm. or ml., as means ± standard error

Group	Tissue	Phospholipids	Neutral lipids	Total cholesterol	Total lipids
A	Liver	3·79 ± 0·51	0·33 ± 0·06	0·19 ± 0·03	4·67 ± 0·41
	Plasma	0·16 ± 0·01	0·13 ± 0·01	0·11 ± 0·02	0·46 ± 0·04
	Aorta	1·03 ± 0·09	11·31 ± 1·16	0·19 ± 0·02	12·68 ± 1·36
B	Liver	3·94 ± 0·56	1·24 ± 0·08	2·24 ± 0·31	8·72 ± 0·94
	Plasma	0·57 ± 0·06	0·49 ± 0·06	1·33 ± 0·14	2·98 ± 0·32
	Aorta	1·09 ± 0·13	9·71 ± 1·07	1·87 ± 0·22	13·18 ± 1·68
C	Liver	3·87 ± 0·49	0·37 ± 0·06	0·39 ± 0·05	5·48 ± 0·67
	Plasma	0·24 ± 0·02	0·15 ± 0·01	0·26 ± 0·03	0·89 ± 0·11
	Aorta	0·98 ± 0·08	9·46 ± 0·89	1·24 ± 0·17	12·46 ± 1·38
D	Liver	3·41 ± 0·58	0·46 ± 0·04	0·62 ± 0·13	6·19 ± 0·72
	Plasma	0·37 ± 0·04	0·31 ± 0·03	0·72 ± 0·08	1·80 ± 0·21
	Aorta	0·95 ± 0·12	10·92 ± 1·27	1·64 ± 0·16	12·59 ± 1·34

Treatment with α-lipoic acid from the beginning of feeding with the high cholesterol diet (group *C*) limited the increases in the lipids of the plasma, liver and aorta to a much smaller extent. When the treatment with α-lipoic acid was started at the end of the high cholesterol feeding (group *D*) it produced a similar though somewhat smaller effect. Even so, the plasma cholesterol values were only about half those of animals which had received cholesterol but no α-lipoic acid.

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Effect of Testosterone Propionate upon the Incorporation of Labelled Glycine into Homogenates of Mouse Kidney

It was shown recently[1] that the rate of incorporation of glycine-1-^{14}C into kidney slice protein of *A/Jax* mice treated with testosterone propionate was significantly higher than into slices from untreated animals. The maximum increase (35–80 per cent) appeared 48 hr. after beginning daily injections of 1 mgm. testosterone propionate, after which the difference between the treated and control series gradually disappeared. A study of some of the characteristics of this response revealed that the difference in incorporation-rates was greatest at low glycine concentrations, and diminished when the glycine concentration of the incubation medium was raised to 4–8 m*M*. It was postulated that under these conditions the effect of this steroid was to facilitate the intracellular accumulation of glycine from a relatively glycine-deficient environment.

As a test of the above hypothesis, experiments were conducted to compare the effects of testosterone propionate upon incorporation of glycine by slices and homogenates of mouse kidney. Female *A/Jax* mice (from Jackson Memorial Laboratories, Bar Harbor, Maine) were given two injections of testosterone propionate (0·1 ml. of a solution containing 10 mgm./ml. in sesame oil) 24 hr. apart, and killed 24 hr. after the second injection. The kidneys were removed and weighed; one was sliced and the slices incubated for 2 hr. in Krebs–Ringer phosphate containing isotopic glycine. The other kidney of a pair was homogenized in nine times its weight of the same medium previously cooled to 0°, and the homogenate incubated for 30 min. The bath temperature was 38·4°. After incubation, the slices were removed, blotted and processed as described previously[1]. The reaction in the flasks containing homogenate was terminated by the addition of 2/3 volumes of 25 per cent (w/v) trichloracetic acid. The precipitate was redissolved in dilute alkali and reprecipitated four more times with 5 per cent trichloracetic acid. Before the last precipitation, 10 mgm. non-radioactive glycine was added to ensure removal of adsorbed glycine. The protein precipitated by trichloracetic acid was washed successively in water, acetone, a mixture of chloroform, ethyl ether and ethanol (1 : 1 : 2), and benzene, and finally plated for counting from benzene. Each sample was counted long enough to limit the counting error to a maximum of 5 per cent.

Table 1. Effects of Testosterone Propionate upon Incorporation into Kidney Slices and Homogenates*

	No. of mice	Kidney weight percentage of body-weight	Incorporation-rate†	
			Slices	Homogenates
Untreated	18	1·23	1·22 ± 0·035	0·087 ± 0·006
Treated	17	1·33	1·65 ± 0·042	0·138 ± 0·006
Increase (per cent)		8	36	57

* The medium used for these experiments contained 1·19 m*M* glycine, specific activity 0·17 mc./m*M*.
† Micromoles of glycine carbon incorporated per gm. protein per hr. Average ± standard error.

Results obtained in two experiments, in which a total of 35 animals was used, are summarized in Table 1. It is clear that although incorporation into mouse kidney homogenate is less than one-tenth as rapid as incorporation into slices, the two processes are stimulated to approximately the same degree by administration of androgen. That the effect of testosterone propionate is specific for incorporation into kidney protein is indicated by the results in Table 2, wherein it may be observed that incorporation by mouse liver homogenate is unaffected by testosterone propionate.

As noted above, earlier experiments with kidney slices showed that the effect of testosterone propionate upon incorporation decreased with increasing glycine concentration. Thus, in one series of experiments, the average increases in incorporation-rates for treated animals were approximately 47 per cent and 13 per cent for concentration ranges of 0·125–1·0 m*M* and

Table 2. Effects of Testosterone Propionate upon Incorporation into Kidney and Liver Homogenates*

	No. of mice	Incorporation rate†	
		Kidney	Liver
Untreated	10	0·036±0·003	0·020±0·002
Treated	10	0·068±0·005	0·020±0·001
Increase (per cent)		89	0

* Kidneys and liver from each group of animals were pooled in three lots and homogenized; two to three samples of each pool were incubated 0·5 hr. at 38·4°. Glycine concentration: 1·07 m*M*, 0·2 μc./ml.

† Micromoles of glycine carbon incorporated per gm. protein per hr. Ave. ± S.E.

Table 3. Response of Mouse Kidney Homogenates to Testosterone Propionate at Various Glycine Concentrations

Glycine concentration m*M*	μc./ml.	Incorporation rate* Untreated	Treated	Increase (per cent)
0·25	0·20	0·027±0·001 (5)	0·041±0·004 (5)	51
0·50	0·20	0·049±0·004 (5)	0·077±0·011 (5)	57
1·19	0·20	0·087±0·006 (18)	0·138±0·006 (17)	59
2·00	0·60	0·112±0·010 (5)	0·192±0·020 (5)	71
4·00	0·60	0·157±0·025 (5)	0·232±0·025 (5)	48

* Micromoles of glycine carbon incorporated per gm. protein per hr. Ave. ± S.E. Numbers in parentheses indicate the number of kidneys used for each concentration.

4·0–8·0 m*M*, respectively. In contrast, the effect of testosterone propionate upon incorporation in homogenates is not significantly affected by changes in glycine concentration within these limits (Table 3).

Our results do not support the hypothesis that stimulation of glycine incorporation by androgen is mediated through an effect upon a concentrative process operating at the level of the cell membrane, since such an effect should be inoperative in cell-free systems. An analogous process, functioning at the subcellular particulate level, is not excluded, however. In view of the considerable difference between incorporation-rates found for slices and homogenates, as well as the difference in the effect of substrate concentration upon the response to testosterone propionate, there remains the possibility that another androgen-sensitive, concentration-dependent component of the incorporation process disappears upon homogenization. Further experimentation, involving studies of the effects of testosterone propionate upon intracellular amino-acid levels, may provide an answer to this problem.

Other anabolic steroids, including testosterone, androsterone, methyl testosterone and methylandrostenediol, also increase the rate of incorporation into mouse kidney homogenates. Hydrocortisone, on the other hand, was distinctly inhibitory, while deoxycorticosterone was devoid of appreciable effect.

This research was assisted by a research grant (*A*-1891) from the National Institute of Arthritis and Metabolic Diseases, United States Public Health Service, Bethesda, Maryland.

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Ribonuclease Activity and Ribonucleic Acid Content of Homologous Human Normal and Cancer Cells

A relationship between the level of ribonuclease activity and ribonucleic acid content has recently been found to exist in the human placenta[1] and in hyperplastic bone marrow of the mouse[2]; such a relationship has also been shown to exist in different normal organs of the mouse[3], as well as different epitheliomas in mice or rats[4]. On the other hand, results obtained with solid[4] and ascites tumours[5] suggest that cancerous epithelium might have less ribonuclease activity than a normal one. We have undertaken a study of the properties of the human uterine cervix, from which homologous normal and cancerous tissues can easily be obtained.

In the present work, superficial biopsies of the uterine cervix epithelium were removed from human uteri presenting a stage I or II carcinoma. In each case, a biopsy was also taken from nearby normal tissues of the same cervix. Each sample was homogenized in distilled water. An aliquot was treated with 0·15 *N* sulphuric acid for 1 hr., and used for the estimation of ribonuclease activity. Another sample was used for the determination of nucleic acids and protein content by the methods already described[3].

The results obtained with these samples, together with samples taken from non-cancerous patients, are shown in Fig. 1. It can be seen that there is a significant correlation between ribonuclease activity and ribonucleic acid content (per unit of protein) for normal and cancerous tissues. The correlation is, however, different in the two cases; for the same ribonucleic acid/protein ratio in both cases, the ribonuclease activity/protein ratio is lower in cancer cells. It can also be seen that, as a rule, the tumour cells contain more ribonucleic acid per unit of protein than the normal cells; they show less ribonuclease activity than the homologous normal control cells. These results, although they are difficult to evaluate owing to the heterogeneity of the material used, suggest that ribonuclease probably plays an important part in cellular ribonucleic acid metabolism.

In respect of cancer cells, it should be noted that exogenous ribonuclease produces a marked inhibition of the growth of spontaneous mammary carcinoma in *C*+ mice[6] and of certain experimental tumours[6,7], while it has no effect on the normal tissues of the host. There may be a correlation between these

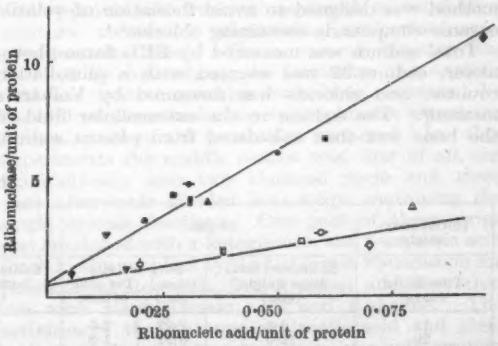

Fig. 1. Relations between ribonuclease activity (measured at *p*H 5) and ribonucleic acid content of homologous normal and cancerous epithelium in the human uterine cervix. Upper curve, normal epithelium; lower curve, cancerous epithelium. Black signs, normal tissues; white signs, cancerous homologous tissues.

findings and the fact that activity of ribonuclease is lower in neoplastic than in normal tissues.

Since the action of exogenous ribonuclease on ascites tumour cells *in vivo* and *in vitro*[6] begins with a stimulation of ribonucleic acid synthesis and an increase in pyrimidine metabolism, endogenous ribonuclease activity might be related to a selective orientation of the metabolism of ribonucleic acid; if so, the decrease of ribonuclease activity observed in the cancerous uterine cervix might correspond to different ribonucleic acid metabolisms in normal and in cancer cells.

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Retention of Sodium-22 in Rat Bone

Three groups of male rats, of about 50, 150 and 300 gm. body-weight respectively, were placed on a low sodium diet, and 5 μc. sodium-22 chloride per kgm. body-weight injected intraperitoneally on day 1. On days 3 and 5 a further injection of 2 μc. per kgm. was given, and on day 7 all were replaced on the stock diet (0·5 per cent sodium). Six female rats each weighing 250 gm. were mated on day 1, and the diet and sodium-22 administered as above; three were replaced on the stock diet on day 14 and the others maintained on the low sodium intake until term. Approximately each 10 days, commencing on day 11, one male from each group was bled from the tail to obtain a plasma sample; humeri and femora were then removed and scraped as clean as possible and weighed. The four bones from each animal were placed in 0·05 *M* silver nitrate in 5 *N* nitric acid, and after standing in the cold for some days the mixture was heated at 100° C. to effect complete solution of organic matter. This method was designed to avoid formation of volatile organic compounds containing chlorine[1,2].

Total sodium was measured by EEL flame photometer, sodium-22 was counted with a scintillation counter, and chloride was measured by Volhard's method[3]. The sodium in the extracellular fluid of the bone was then calculated from plasma sodium and chloride and bone chloride, and its radioactivity from the plasma radioactivity. These values were subtracted from the total sodium and radioactivity found in the bones to obtain an estimate of the true bone sodium and radioactivity. From tables[4] estimates were obtained of the total bone-weight of the rats at the various times, and from these and the radioactivity measurements estimates have been made of the percentage retention of sodium-22 in the total skeleton (see Table 1). While on the low sodium diet, the rats gained weight less rapidly than the tables suggested, so that the estimates of total bone activity may be slightly too high, especially for the first two times. In some large rats the bones of which were analysed 24 hr. after injection about 10 per cent of the administered dose was initially deposited in the skeleton.

Only two females of each group delivered litters, and the young were allowed to grow to about 100 gm. body-weight. Then the blood and bones of six young from each group were treated as above, pooling all the samples in each of the two groups. When the mothers had been exposed to the sodium-22 and low sodium diet during only the first two weeks of pregnancy, the mean retention of the isotope in the four bones of each offspring two months later was 10^{-5} μc. ($P < 0{\cdot}01$); this corresponds to approximately 0·005 per cent of the dose administered to the mother per fœtus. When the mothers had been kept on the low sodium diet throughout pregnancy, the mean retention of sodium-22 in the four bones of the offspring was 3×10^{-5} μc. ($P < 0{\cdot}001$), or approximately 0·015 per cent of the dose per fœtus. There was no demonstrable sodium-22 in the plasma of any of these offspring at death.

It is impossible to draw any detailed conclusions from these preliminary figures, but some sodium-22 was laid down relatively permanently in the growing bones of the rats—more in the younger animals the growth-rate of which was higher. This would appear to be about 0·5–1 per cent of the administered dose, or of the order of 5–10 per cent of the fraction originally laid down in the bone at the end of 24 hr. The specific activity of the plasma declined far more rapidly as expected, with a half-period of about three days in the large rats and one and a half days in the small ones. Whether the whole of the isotope would ultimately have been lost, as suggested by accumulation experiments[5], cannot be decided from the above figures.

How relevant these findings with rats (the bones of which were still growing during the entire experimental period) are to adult humans is not known, but certainly the growing bone of the child may be expected to behave in a similar manner.

The above work was performed during the tenure of a Nuffield Foundation Dominion Travelling Fellowship at the Department of Chemical Pathology,

Table 1

Initial body-weight	50 gm.			150 gm.			300 gm.		
Time killed (days)	Estimated total bone weight (gm.)	Bone activity (mμc./gm.)	Per cent of dose	Estimated total bone-weight (gm.)	Bone activity (mμc./gm.)	Per cent of dose	Estimated total bone-weight (gm.)	Bone activity (mμc./gm.)	Per cent of dose
11	9·2	1·23	2·5	17·8	2·15	2·6	25·4	1·85	1·7
20	12·0	0·91	1·3	18·9	0·75	1·0	25·4	0·91	0·85
29	14·1	0·41	1·0	19·8	0·41	0·6	25·5	0·41	0·4
43	16·6	0·47	0·9	21·0	0·47	0·7	25·5	0·47	0·45
54	18·1	0·55	1·1	21·8	0·46	0·7	25·6	0·55	0·5
63	19·2	0·35	1·0	22·2	0·24	0·4	25·6	0·35	0·3

King's College Hospital Medical School (University of London). Thanks are due to Miss M. Sandiford for technical assistance, to the Research Fund of King's College Hospital and the Medical School for apparatus, and to Dr. J. F. Fowler and Prof. C. H. Gray for advice and encouragement.

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Lesions in the Hypertensive Rat Kidney produced by Hydralazine

The use of hydralazine (1-hydrazinophthalazine) for the control of human hypertension was followed by the recognition of serious and undesirable side-effects. The similarity of some of these effects to disseminated lupus erythematosus led to the investigation of the influence on the normal dog of toxic doses of this drug[1,2]. These experiments failed to provide satisfactory evidence for the production in the dog of an experimental model of disseminated lupus erythematosus.

To reproduce more closely the conditions under which the desired changes are found clinically, increasingly large amounts of hydralazine have been given by single daily intramuscular injection to rats previously subjected to a regime shown to cause systemic hypertension. The regime comprised left nephrectomy, the subcutaneous implantation of 100 mgm. of slowly absorbed deoxycortone acetate, and the substitution for drinking water of 1 per cent sodium chloride. The development of hypertension was suppressed by the hydralazine injections, each injection being followed by an abrupt fall in blood pressure succeeded by a linear rise continuing throughout the following 24 hr.

In these circumstances the intact kidneys of the treated animals were found to contain a surprisingly large number of focal glomerular lesions. The lesions were usually confined to one segment of the glomerular tuft, and varied from focal necrosis, with aneurysmal capillary dilatation, to segmental replacement fibrosis; they were not accompanied by arterial or arteriolar changes.

In control animals subjected to the same hypertensive regime and injected daily with an inert fluid the tubular effects of deoxycortone were recognized but were accompanied only by glomerular enlargement and seldom by the characteristic glomerular lesion seen when larger amounts of deoxycortone are more rapidly absorbed. Similar deoxycortone effects were also present in the hydralazine-treated animals.

Hydralazine may therefore influence the integrity of the rat glomerulus under certain carefully defined conditions. The effect is indirect, and is observed neither in the normal animal nor in the animal from which one kidney has been removed but which has received no deoxycortone. The glomerular damage clearly cannot be satisfactorily explained in terms of sustained hypertension, nor is it likely to be a result of the gradual rise in blood pressure which is the sequel of the acute hypotension following each daily injection of hydralazine. It is, however, possible that the damage may be directly related to the daily hypotensive episode.

The production of these lesions in the rat glomerulus is considered to be of importance, partly because their recognition provides the first satisfactory evidence of a damaging effect of hydralazine upon the kidney in experimental hypertension, and partly because of the suggestion that episodic hypotension may be the immediate causative agent. In addition, the experiment provides some evidence for the suggestion that glomerular lesions due to deoxycortone can be distinguished from those due to variations in blood pressure, and thus that the glomerular effects of deoxycortone are not necessarily due to hypertension.

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Determination of Transaminase Activity of Serum Protein Fractions separated by Paper Electrophoresis

The electrophoretic mobility of glutamic–oxalacetic acid transaminase in blood serum has been found to be between those for α_2- and β-globulins[1]. In our experiments[2] the glutamic–oxalacetic acid transaminase was associated mainly with α_2-globulins. This communication deals with this transaminase and glutamic–pyruvic acid transaminase and their relations to serum protein fractions.

Blood sera of six patients with characteristic activities of both enzymes were studied. 0·2-ml. samples of sera were electrophoretically separated on Whatman No. 1 filter paper strip (14 cm. × 35 cm.) in 5 hr. Barbital buffer of *p*H 8·6, ionic strength 0·1, was used with a voltage of 350 V. and a current of 0·5–0·8 m.amp. per cm. The marginal sections (3 cm.) were stained for proteins with bromthymol blue. The middle section of paper was cut into corresponding protein fractions and tested for their transaminase activity. The method for simultaneous determination of glutamic–oxalacetic acid and glutamic–pyruvic acid transaminases with an incubation mixture containing glutamate, oxalacetate and pyruvate was used. The action of enzymes was followed by determining the formation of L-aspartic acid and L-alanine, which have been estimated by the ninhydrin method after electrophoretic separation from aliquots of the incubation mixture[3]. In other experiments the middle section was, first of all, cut longitudinally into two identical parts and these were afterwards divided into strips containing the single protein fractions. One part of these strips was incubated with α-ketoglutaric and L-aspartic acid (both kindly supplied by the California Foundation for Biochemical Research, Los Angeles) and the other one with α-ketoglutaric acid and L-alanine. The activities of the glutamic–oxalacetic acid and glutamic–pyruvic acid transaminases in single protein fractions were assayed by hydrazone methods[4,5].

The distribution of transaminases on blood serum protein fractions is presented in Table 1.

Table 1

Diagnosis	Percentage of total Glutamic–oxalacetic acid transaminase activity associated with serum protein fractions					Glutamic–pyruvic acid transaminase activity associated with serum protein fractions				
	γ	β Globulins	α_2	α_1	Albumins	γ	β Globulins	α_2	α_1	Albumins
Infectious hepatitis (2 cases)	2	7	82	2	7	7	81	8	1	3
Obstructive jaundice (metastatic carcinoma)	7	12	75	5	1	18	43	23	8	8
Acute myocardial infarction (3 cases)	(0–8)	(4–17)	(67–89)	(0–10)	(0–10)	(5–12)	(41–90)	(2–36)	(0–21)	(0–19)
Range of values										

The results show that in the pathological sera used the activity of glutamic–oxalacetic acid transaminase is mainly bound with α_2-globulins, and that of glutamic–pyruvic acid transaminase with β-globulins.

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Relationship between Porphyrin and Isoniazid Resistance of *Mycobacterium avium*

It has been reported that a decrease in catalase activity is observed when tubercle bacilli acquire isoniazid resistance[1], and later it was demonstrated that hæmin is required for growth by some of these resistant strains[2]. We have found that the amount of a red fluorescent substance in sensitive strains of *M. avium* (Jûchô, Takeo and 607) is smaller in strains resistant to isoniazid: while the sensitive organism contained 5·5 mgm. red compound/kgm. bacteria, those which were resistant to 250γ isoniazid contained only 2·1 mgm. compound/kgm. bacteria. The sensitive and resistant strains discussed in this communication were cultured in a glycerin–bouillon medium containing no isoniazid.

The red fluorescent substance was extracted with acetone from the organism. The acetone extract was concentrated *in vacuo* and the concentrate was diluted with two volumes of water, then extracted with ether. The ether extract was evaporated *in vacuo* and the residue was purified by the conventional methods for porphyrin extraction. The red material thus obtained had absorption maxima at 624, 597, 568, 529, 495 mμ (in ether solution); relative intensities 495 > 529 > 568 > 624 > 597. The paper chromatographic analysis of this compound gave evidence that the compound was coproporphyrin III ester, a 4-carboxyporphyrin ester[3–5]. The hydrochloric acid number of the hydrolysis product was 0·09.

Todd[6] has isolated coproporphyrin III tetramethyl ester from *M. karlinski* and also reported the presence of the same porphyrin in *M. stercoris* and *M. smegmatis*. The present porphyrin was shown to be identical with that of *M. smegmatis* by paper chromatography. On account of the low yield we could not obtain the red substance in a crystalline state, but the above evidence indicates that the substance is coproporphyrin III tetramethyl ester.

We have added the free coproporphyrin obtained by the method described above to the medium of the isoniazid-resistant *M. avium* (250γ resistant Jûchô strain) and measured the catalase activity by the method of Euler and Josephson[7]. The value thus obtained was 1·236; on the other hand, the value for the resistant bacterium cultivated without coproporphyrin was 0·115. Thus the value was more than ten times greater in the presence of the porphyrin but no difference in the degree of resistance resulted. This evidence suggests that there is no decisive relation between isoniazid resistance and the lack of catalase activity of the bacteria.

We are greatly indebted to Profs. Y. Hirata, K. Hotta and T. Mori for valuable advice. We are also grateful to T. Shoda for invaluable assistance and to Prof. Y. Yamamura, who kindly measured the catalase activity.

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The Latent Period after Infection with Tobacco Mosaic Virus and Virus Nucleic Acid

The process of infection by plant viruses is not so well known as that for animal viruses and bacteriophages. The main reasons are that tissue cultures are not yet available in which all cells can be uniformly infected and that the methods for determination of the activity are not sensitive enough. Experiments of this kind have been carried out with total plants or pieces of leaves. Siegel *et al.*[1] studied the early events of infection with tobacco mosaic virus by an indirect method, measuring the ultra-violet sensitivity of infective centres in *Nicotiana glutinosa*. An increase in ultra-violet resistance occurred 5 hr. after infection at 20° C. This time can be considered as the lag phase. Other results to demonstrate the increase of virus concentration directly are obscured by the fact that the adsorbed virus which has not penetrated and therefore does not participate in the infection is not removed from the surface of the leaves[2]; further, the methods of determination were not sensitive enough[3].

For the detection of small amounts of viruses the bioassay is by far the best method. Using the local lesion test on *Nicotiana glutinosa* we found that a minimal concentration of 10^{-12}–10^{-13} gm. tobacco mosaic virus/ml. was detectable. 25 leaves powdered with 'Carborundum' were used for each dilution. It seemed probable that the minimal infective dose is smaller in plants reacting with systemic symptoms. Young plants of *Nicotiana tabacum* (Samsun) were inoculated with tobacco mosaic virus solutions, again adding 'Carborundum'. The effect was variable, but using a considerable number of plants, we found a 50 per cent infection with a dilution of 10^{-16} gm. tobacco mosaic virus/ml. We applied 5 ml. per plant and this dose is equal to 10 virus particles (Table 1). This test is rather laborious and several precautions were necessary to avoid misleading results. The test may only be used for qualitative purposes.

Table 1. Infectivity of Dilutions of Tobacco Mosaic Virus on *N. tabacum*. Controls were inoculated with Phosphate Buffer

Tobacco mosaic virus conc. (gm./ml.)	Infected plants / Total number	Percentage infected
10^{-9}	22/25	88
10^{-10}	4/25	16
10^{-11}	29/40	72
10^{-14}	51/60	85
10^{-15}	37/75	54
10^{-18}	0/10	0
10^{-20}	0/10	0
Control	0/68	0

By these methods of bioassay and other methods we have investigated the process of infection in young plants of *Nicotiana tabacum* (Samsun). We inoculated three leaves of each plant with 10^{-6} gm. tobacco mosaic virus/ml. in 0·1 *M* phosphate buffer, *p*H 7·2. The leaves were previously dusted with 'Carborundum'. In order to remove the adsorbed virus particles, the leaves were rinsed with water and then with diluted tobacco mosaic virus antiserum. The infected plants were maintained in a thermostat at 23° C. and had constant illumination. After certain intervals the primarily infected leaves of groups of five plants were harvested. The homogenates of these samples were tested on *Nicotiana glutinosa*, as described above. By means of a reference curve, the amount of virus per gm. leaves was calculated from the number of local lesions.

A typical experiment which is easily reproducible is shown in Fig. 1. After the latent period, multiplication is rapid, but it slows down when a concentration of about 10^{-7} gm. virus/ml. is reached in the tissue. For determining the latent period the curve must be extrapolated to the time when the first complete virus particle appears in the leaf. This corresponds to a concentration of 7×10^{-17} gm. tobacco mosaic virus/gm. leaf. The extrapolation led to a latent period of about 30 hr. Even with the very sensitive test in *Nicotiana tabacum*, we never found an infective virus particle before the end of the latent period. In the first 30 hr. the virus concentration is probably less than 10^{-16} gm./ml. This indicates that there is a true latent period after infection. The latent period in *Nicotiana tabacum* seems to be much longer than that in *Nicotiana glutinosa* as found by the ultra-violet method[1].

Gierer and Schramm[4] showed that the ribonucleic acid isolated from tobacco mosaic virus by phenol extraction is infectious. Therefore it is probable that, in the cell, the external virus protein shell has to be removed before multiplication can start. If this

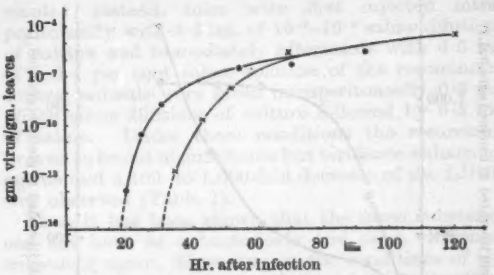

Fig. 1. Increase of virus concentration after infection with tobacco mosaic virus (×—×—×) and virus ribonucleic acid (●—●—●) in *Nicotiana tabacum*

removal is a slow process, the latent period should be reduced after infection with the isolated virus ribonucleic acid. We infected tobacco plants with ribonucleic acid solutions of the same infectivity as in the previous experiments with tobacco mosaic virus. Sometimes the ribonucleic acid and tobacco mosaic virus experiments were run parallel in the same thermostat. From Fig. 1 it can be seen that the increase of the activity of the virus occurs 10–12 hr. earlier than after infection with the virus. This is evidence that the release of ribonucleic acid from the virus takes several hours. However, it is not clear why the ribonucleic acid itself has such a long latent period. The events in this remaining latent period require further study. It should be mentioned that, by extraction of the virus particles from the leaves, the virus ribonucleic acid and other precursors can be destroyed by enzymes. Our experiments confirm the results of Siegel *et al.*[1], who also observed a reduction of the lag phase in infection with ribonucleic acid.

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Lysis of Fungal Mycelia by Bacterial Enzymes

Many investigations have been published[1] on lysis of bacterial cells by microbial enzymes, but there seems to be few references to the lysis of fungal mycelia by microbial enzymes. A bacterial strain which caused visible lysis of *Aspergillus oryzae* mycelia has been isolated from soil. This strain belongs to the *Bacillus circulans* species; it is Gram-negative, with spore-forming rods (spore: oval, terminal to subterminal), motile with peritrichous flagella, it reduces nitrate, is negative to acetylmethylcarbinol, and produces acid from glucose without evolving gas.

When this strain was inoculated into a flask culture of *A. oryzae* (in Czapek–Dox medium), which had been previously shaken for 24 hr. at 30° C., almost all the mould mycelia disappeared after 80 hr. shaking at 30° C. The culture fluid was centrifuged at 7,000*g* for 30 min. to remove bacterial cells grown in the mixed culture, and a pale brownish supernatant was obtained.

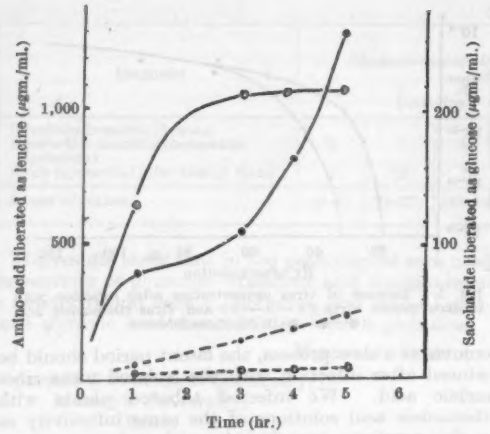

Fig. 1. Lytic action of the enzyme on living mycelial cells. 1 gm. of the living mycelial cells was suspended in 20 ml. of the lytic enzyme solution, and the mixture was incubated at 37° C. ●—●, Amino-acid; ○—○, saccharide; ● - - - ●, amino-acid (control); ○ - - - ○, saccharide (control)

The supernatant was brought to 0·7 saturation with ammonium sulphate and stored in an ice-box overnight. The precipitate was collected by centrifugation and dissolved in *M*/50 tris-buffer (*p*H 6·8). The solution was dialysed against the same buffer for 48 hr. at 4° C. 1 gm. (wet weight) of living mycelial cells of *A. oryzae* was suspended in 20 ml. of this enzyme solution and incubated at 37° C. About 5-ml. portions of this mixture were sampled at 1-hr. intervals, and the hexose and amino-acid liberated were determined by the anthron method[2] and by Stein and Moore's method[3] respectively. As control, the boiled (100° C., 5 min.) enzyme solution and living mould cells were used. Fig. 1 shows the experimental results.

The cell walls of the mycelia were then used as the substrate, instead of living mycelia. The cell walls were prepared as follow: mycelia were disrupted by use of a Waring blendor, and disrupted mycelia were then treated with a crystalline bacterial protease (100 μgm./ml.). This mixture was filtered and the residual cell material (cell walls) was washed with water. The cell walls thus obtained were dried *in vacuo* over calcium chloride.

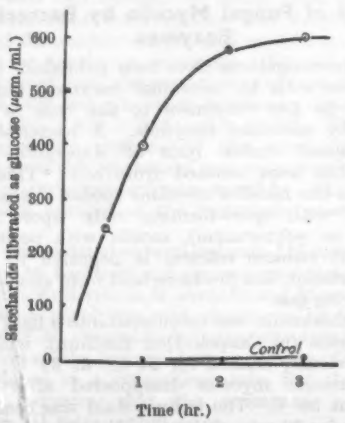

Fig. 2. Lytic action of the enzyme on the cell walls of *A. oryzae*. 25 mgm. of the cell walls was suspended in 10 ml. of the lytic enzyme solution, and the mixture was incubated at 37° C.

Fig. 3. (*a*) Rough layer of the cell-wall surface before treatment with the lytic enzyme; and the fibrous structure appeared on the inner side of the cell wall. (× 20,000). (*b*) After treatment with the lytic enzyme for 3 hr. The rough layer of the cell wall has disappeared, and the granular layer is observed; the fibrous structure is degraded. (× 20,000)

The course of degradation of the cell-wall material by the crude enzyme preparation from *B. circulans* is shown in Fig. 2, from which it seems that this enzyme acts on the cell walls directly. When treated with this enzyme, the rough surface layer seen before treatment disappeared, and a granular layer not visible before treatment appeared in the electron microscope (see Fig. 3).

This enzyme did not liberate either hexosamine or amino-acid (as detected by paper chromatography), but liberated a saccharide which was precipitated with 50 per cent alcohol. Paper chromatographic methods were used in attempting to identify the saccharide, but the spot remained at the origin. Hence it seems that the saccharide is a polymer of hexoses. The polysaccharide was then hydrolysed with 75 per cent sulphuric acid and neutralized with barium carbonate and chromatographed with pyridine/ethyl acetate/water (1 : 2 : 1). Glucose and galactose were identified in the acid hydrolysate.

It was further confirmed that this enzyme acts on the living mycelial cells of *A. aojae* KS., *Pen. purpurogenum* var., and *Mucor M*-5 but not on *Rhizopus R*-1-8.

We thank Prof. K. Sakaguchi, Dr. M. Amaha and Dr. M. Nomura (University of Tokyo) for their encouragement and guidance.

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Enhancement of Mouse-virulence of Group *A* Streptococci by Bactericidal Resorcinols

It seems to be generally agreed that agents capable of enhancing the virulence of bacteria, particularly mucins, do so by interfering with the defences of the host[1–3]. Recently, it was shown[4] that broth or peptone injected intraperitoneally into *W*-Swiss mice even 1 hr. after a non-lethal saline suspension of group *A* streptococci converts the non-lethal dose into an *LD*100, the time-lag pointing again to an action on the host. The present communication brings further evidence in this respect; it also shows that substances bactericidal *in vitro* can act as virulence-enhancing agents *in vivo*.

The resorcinols were the 4-*n* substituted alkyl derivatives, ethyl, propyl, butyl, amyl and hexyl resorcinol[5]. The intraperitoneal injection of 0·5 ml. of a 0·1 per cent saline solution of these compounds is without marked effect on mice.

Two strains of group *A* streptococci were used, one type 12, the other type 22; the *LD*100 was 0·5 ml. of a 10^{-3} saline dilution of culture, the culture itself containing about 2×10^7 viable cells per ml. The organisms were grown in broth consisting of 2 per cent 'Oxoid' peptone, 0·8 per cent 'Oxoid Lab. Lemco' broth powder, 0·2 per cent glucose and 0·2 per cent sodium bicarbonate made up in distilled water, sterilized by Seitz filtration and tubed in 4-ml. lots in ¼ oz. screw-capped Bijou bottles.

Two types of experiment were carried out. First, 18-hr. old cultures of streptococci were diluted 1 in 10 in 0·1 per cent solutions of the various resorcinols and kept, with occasional shaking, at room temperature, 24°, for 30 min., a 10^{-1} saline-dilution of culture serving as control; thereafter *W*-Swiss mice were injected intraperitoneally with 0·5 ml. of the suspensions from which viable counts were made[6]; all control animals and all animals injected with the ethyl and propyl resorcinol suspensions of organisms died. There were no deaths in the groups injected with the organisms exposed to butyl, amyl and hexyl resorcinol. The butyl, amyl and hexyl suspensions were found sterile whereas the ethyl, propyl and saline suspensions still contained approximately the same number of viable organisms.

In the second group of experiments the organisms were not exposed *in vitro* to the action of the resorcinols: instead, mice were first injected intraperitoneally with 0·5 ml. of 10^{-2}–10^{-6} saline dilutions of culture and immediately afterwards with 0·5 ml. of a 0·1 per cent saline solution of the resorcinols; control animals were given intraperitoneally 0·5 ml. of the saline dilutions of culture followed by 0·5 ml. of saline. Under these conditions the resorcinols proved to be not disinfectants but virulence-enhancing agents and a 100- to 1,000-fold decrease of the *LD*100 was observed (Table 1).

Table 1. Effect of 4-*n* Alkyl-substituted Resorcinols on Mouse-virulence of Group *A* Streptococci

Strain	Alkyl resorcinol	Deaths in groups of 16 mice inoculated with the following culture dilutions*				
		10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}
Cumming Type 22	None-saline control	16	8	0	0	0
	Ethyl	—	8	3	0	0
	Propyl	—	9	5	0	0
	Butyl	—	—	16	13	0
	Amyl	—	—	16	16	11
	Hexyl	—	—	16	16	9
1965 Type 12	None-saline control	16	10	1	0	0
	Ethyl	—	9	7	0	0
	Propyl	—	13	5	0	0
	Butyl	—	—	16	14	0
	Amyl	—	—	16	16	11
	Hexyl	—	—	16	16	12

* Mice injected intraperitoneally, first with 0·5 ml. of the stated saline dilutions of culture, then with 0·5 ml. of saline or of a 0·1 per cent saline solution of an alkyl resorcinol.

Thus it has been shown that the same substance can act both as a bactericide and as a virulence-enhancing agent, depending on the conditions of the experiment, and that in the alkyl resorcinols examined virulence-enhancing activity parallels bactericidal activity. The experiments rule out a true enhancement of virulence of the infecting organism and demonstrate that the action of the resorcinols is on the host.

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A Possible Source of Error in the Chemical Detection of Indolyl Acetic Acid in Plants

During investigations on the growth substances of fruits of cacao and bananas (*Musa* spp.), it was of interest to find that a substance was present in seeded bananas which gave a pink colour with ferric chloride/perchloric acid or *p*-dimethyl amino-benzaldehyde/hydrochloric acid, corresponding to the R_F of indolyl acetic acid and to the zone of bioassay using the wheat coleoptile straight-growth test. Subsequent experimentation showed that although the straight-growth response was probably due to indolyl acetic acid, the colour reaction was not. The technique of extraction and bioassay was essentially similar to that of Bennet-Clark and Kefford[1] with some minor modifications. Duplicate samples of the acid fraction from seeded banana fruit extracts were developed by the descending method on Whatman's 3 *MM* or No. 1 chromatography paper in *iso*propanol/ammonia/water (10 : 1 : 1). Synthetic indolyl acetic acid was developed as a marker. One sample was bio-assayed by the wheat straight-growth test and the other sprayed with ferric chloride/perchloric acid (1 ml. 0·05 *M* ferric chloride + 50 ml. 5 per cent perchloric acid).

The ferric chloride/perchloric acid spray, on heating, developed a pink or pinkish-purple spot on the chromatogram corresponding to both the zone of growth activity after bio-assay and to the indolyl acetic acid marker. The top half of the chromatogram ($R_F < 0·5$) was usually streaked with oxidized polyphenolic substances which could be detected visually without treatment by the brown colour and confirmed by diazotized *p*-nitraniline. It was found that if synthetic indolyl acetic acid was spotted into

the brown area, dried and afterwards heated with ferric chloride/perchloric acid, the final colour development was not the more typical pink but pinkish-purple, similar to the colour developed with the banana extracts. The evidence from the R_F behaviour, colour reactions with ferric chloride/perchloric acid and bio-assay activity therefore suggested that the banana auxin was probably indolyl acetic acid.

However, in a detailed series of extractions from bananas of different ages it was noted that in some experiments the colour reaction with ferric chloride/perchloric acid could be obtained but without the corresponding growth activity after bioassay. Luckwill[2] has pointed out the necessity of using more than one developing solvent in order to confirm the presence or absence of indolyl compounds in plant extracts, and of the necessity of critical bioassay. Afterwards the acidic fractions of seeded bananas were run in 70 per cent alcohol and butanol/acetic acid/water (4 : 1 : 5). In 70 per cent alcohol the results were essentially similar to that found with the *iso*propanol solvent except that the growth activity, indolyl acetic acid marker and pink spot developed by ferric chloride/perchloric acid were found in the region of R_F 0·55. However, in butanol/acetic acid/water the zone of the growth activity and indolyl acetic acid marker were found consistently at R_F 0·95, whereas the coloured product developed with ferric chloride/perchloric acid appeared at 0·79–0·80. This evidence indicated that indolyl acetic acid was present in seeded bananas but it was not responsible for the colour reaction with perchloric acid.

In order to confirm the presence of indolyl acetic acid, duplicate samples from the extracts of seeded bananas were first run in *iso*propanol/ammonia and the zone of growth activity from one chromatogram, determined by bioassay of the other, was eluted with ether. The ether extract was concentrated under reduced pressure and re-chromatographed on Whatman No. 1 paper, using distilled water as the developing solvent. The zone of growth activity appeared at R_F 0·9, corresponding very closely to the indolyl acetic acid marker at R_F 0·89. The evidence from the R_F values of the banana auxin in the various solvents mentioned provides evidence that it is either indolyl acetic acid or an indole compound very closely allied to it.

The nature of the unknown compound which gave the pink colour with perchloric acid was of interest, particularly as the R_F behaviour was similar to indolyl acetic acid in two different solvents, one of which is commonly used for the separation of the acidic auxins.

Simmonds[3] has shown that leucoanthocyanidins are present in banana fruits. It was found that the unknown compound, after spraying with 10 per cent hydrochloric acid in butanol, gave a pink colour on heating but not in the cold. Furthermore, on spraying with vanillin/hydrochloric acid (1 gm. vanillin dissolved in 15 ml. of concentrated hydrochloric acid + 35 ml. butanol), a pink colour was developed without heating. The hydrochloric acid and the vanillin reactions, modified from a method described by Bate-Smith[4], are together indicative that the compound responsible for the colour reactions is almost certainly a leucoanthocyanin. Although straight-growth promoting activity is not associated with the leucoanthocyanins, it is very possible that if a range of both temperate and tropical fruits is examined for indolyl compounds by paper chromatography and straight-growth bio-assay, confusing colour reactions with conventional chemical sprays may be found in the presence of mobile leucoanthocyanins.

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Root Diffusates of *Solanum tuberosum* and *Digitalis purpurea*

The hatching factor of the potato root eelworm has been shown to possess certain affinities with the cardiac glycosides[1] due, presumably, to the unsaturated lactone ring it is thought to contain[2]. The factor is contained in diffusates from the roots of growing potato plants[3]; but it has recently been shown that it can also be obtained from their leaves[4]. On the other hand, although the presence of cardiac substances in the leaves of the foxglove has been known for centuries, diffusates from their roots do not appear to have been examined: I have now found that such solutions have many of the properties of the potato root diffusates.

(1) Perfusion of the isolated frog heart shows that both potato and foxglove root diffusates possess cardiotonic activity.

(2) Colorimetric assay with either alkaline picric acid or 3,5 dinitro benzoic acid, methods used for cardiac glycosides[5,6], give reasonable agreement with heart assay. (In the case of the potato root diffusate, the colorimetric methods show promise for assessing hatching activity, as will be shown in full elsewhere.) With the benzoic acid reagent, both diffusates give an absorption peak at λ 385–390 mμ as shown in Fig. 1; digitoxin also gives this peak, which, so far as I am aware, has hitherto not been recorded: but it, and *Digitalis* tinctures, give other peaks too, not shown by the diffusates.

(3) Proctor *et al.*[7] have recently shown that digitoxin behaves as a peroxide in solution: solutions of both diffusates show peroxide activity after concentration in a Towers's evaporator. In the case of potato root diffusate the treated solution is relatively at least as active in stimulating hatching as the original.

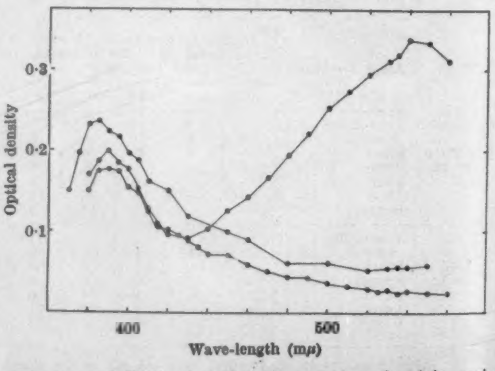

Fig. 1. 3,5 Dinitro benzoic acid reagent, and potato root diffusate (●), foxglove root diffusate (◑), and digitoxin (◐)

The diffusates probably contain a variety of substances, so that any conclusion must necessarily be provisional; moreover, none of the above points is critical evidence on its own. But, collectively, and together with the chemical evidence of Todd and his colleagues for the possible lactone structure of the hatching factor[3], the evidence is all consistent with the view that the two diffusates contain substances which have a chemical affinity with each other and with the cardiac glycosides.

Cardiac glycosides have been shown to influence sodium–potassium transport[8–11], and this property has also been demonstrated to be possessed by simpler lactones[12]. We have no direct evidence, as yet, that the hatching factor has this capacity, but, judging from the influence of ions on its activity, this does not appear to be unlikely. If this is so, one wonders whether the production of substances of this sort by plant roots may not be connected with the transport of ions by the roots themselves.

I am grateful for the tolerance and help of my chemical colleagues and for the facilities they have placed at my disposal. A grant from the Nuffield Foundation is gratefully acknowledged.

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Immune Reactions to *Trichostrongylus colubriformis* Infestation in Sheep

In infestation of sheep with *Trichostrongylus colubriformis* both the intake of larvæ and infestation with adult worms stimulate the production of antibodies. These can be detected by means of a complement fixation test with an antigen prepared from ground larvæ[1].

During studies on the immune reactions of sheep to infestation with *T. colubriformis* it was found that after challenge of infested sheep with a further dose of larvæ, the body-weights of some remained static, or even declined, although the fæcal worm-egg count was virtually negative and the serum titre remained at a high level. Several such sheep were slaughtered and although very numerous adult *T. colubriformis* were recovered from the small intestine, few eggs were present in the females. In one case, from which approximately 20,000 worms were recovered, the serum titre had risen to 1/40 three weeks after challenge with 20,000 larvæ and remained at 1/40 or 1/80 until the lamb was slaughtered nine weeks later. During this period the worm-egg count never exceeded 400 per gm. fæces.

Further experiments revealed that the worms had reached maturity in the normal time, but that the females produced very few eggs. It was apparent that, in these cases, there is a suppression of egg-production associated with a sustained high serum titre, and that the worm-egg count is not then a reliable indication of the degree of infestation. A similar phenomenon has been noted by Roberts[2] in infestations of cattle with *Haemonchus placei*.

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Dependence on Light of the Reversible Uptake of Inorganic Phosphate by *Hydrodictyon*

In the colony-forming green alga, *Hydrodictyon reticulatum*, uptake and metabolism of phosphate have been followed up by ordinary analytical methods (fractionation by the conventional trichloracetic acid technique, determination of phosphates with a modified procedure of Fiske and Subbarow[1]). The predominant feature in the changes of the phosphate fractions during a long-term culture with intermittent illumination (12 hr. light : 12 hr. darkness) is a marked increase in the large cells of the alga of the inorganic phosphate-level during the time of illumination. A comparable light-dependent accumulation of ions has been reported for other objects (reviewed by Brauner[2]), most recently for chloride by van Lookeren-Campagne[3]. In the case of *Hydrodictyon*, however, the accumulation of inorganic phosphorus in the light is reversible[4], since the low level of intracellular phosphate is completely restored during the dark time. This is shown in Fig. 1. The changes of the inorganic phosphorus have been found in the cells and, at the same time, in the surrounding nutrient solution. The differences in the phosphorus-level are not directly induced by *p*H changes in the medium.

Photosynthetically active red and blue light is more effective in phosphate accumulation than is green light of equal energy (Schott glass filters). Absence of carbon dioxide prevents the light-dependent accumulation almost completely. Persistent high

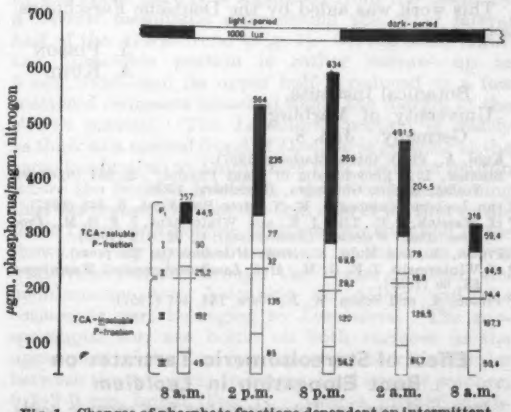

Fig. 1. Changes of phosphate fractions dependent on intermittent illumination of *Hydrodictyon*, based on total nitrogen (Kjeldahl). P_i, inorganic orthophosphate; I, stable phosphates soluble in trichloracetic acid; II, unstable phosphates soluble in trichloracetic acid (7 min.); III, unstable phosphates soluble in trichloracetic acid (7 min.); IV, stable phosphates insoluble in trichloracetic acid. Complete nutrient medium, 20° C.

levels of inorganic phosphorus can be obtained by shortening the darkness times versus times of illumination, and especially by continuation of the latter. These conditions are unfavourable for the vegetative development of the alga. The accumulation of inorganic phosphorus cannot be considered an obligatory ingredient or consequence of photosynthetic activity. This follows from the fact that low light intensities (for example, 300 lux), much below photosynthetic saturation but above compensation of respiration, are inactive in phosphate accumulation. The latter appears from about 1,000 lux on, where photosynthesis is beyond its linear dependence on light intensity. Thus we assume that phosphate accumulation and maintenance in the cell will be only exhibited at the expense of a certain surplus amount of energy available additional to the requirement of the photosynthetic mechanism proper.

Apart from the shifting of the inorganic phosphorus-level, reversible or irreversible changes in the different phosphate fractions of the algal cells during times of darkness and illumination are comparatively small, so far as they can be observed by usual analytical methods. The questions concerned will be discussed elsewhere[5]. Here it must suffice to say that polyphosphates, distributed between the fractions respectively soluble and insoluble in trichloracetic acid, can be increased by long illumination without additional carbon dioxide[6]. On the other hand, we did not obtain any evidence for an effective formation and utilization of polyphosphates in the balance of energy of the cells during changes in illumination and darkness and in the course of photosynthetic periodicity[7]. Labile phosphates of all kinds seem to be especially sensitive toward a lowering of the external supply of phosphorus.

This work was aided by the Deutsche Forschungsgemeinschaft.

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Effect of Stereoisomeric Tartrates on Root Elongation in *Lepidium*

It was shown by Tetjurew[1] that free organic acids, especially malic and citric acids, exert an inhibitory effect upon seed germination.

Evenari[2] is of opinion that the inhibition by organic acids is not caused by the hydrogen-ion concentration alone, but that "it is mainly by their intrinsic natures as specific acids that they are inhibitors". This view is supported by the results of some experiments reported here, demonstrating the specific influence of different stereoisomeric forms of tartaric acid upon early stages of root elongation in cress (*Lepidium sativum* L.).

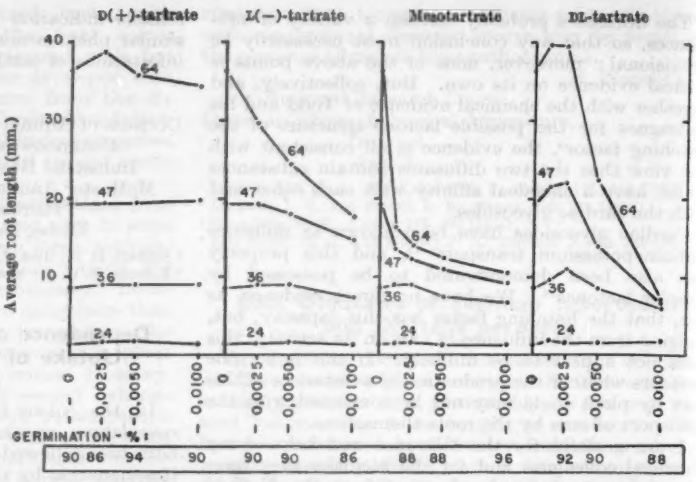

Fig. 1. Length of cress roots after 24, 36, 47 and 64 hr. in various concentrations of the different stereoisomeric tartrates. Abscissa: concentration of tartrate, moles per litre. Each point on the figure represents the average of fifty seeds. The seeds were harvested in 1955 and tested in December 1957. Below: germination percentages after 64 hr. in the different solutions

The technique was as follows. The different tartaric acids, analytical grades, were obtained from A. G. Fluka, Switzerland. As a precaution against microbiological contamination and chemical decomposition, the test solutions were made up the day they were to be used.

The seeds were germinated in Petri dishes on six layers of filter paper moistened with 10 ml. of neutralized tartaric acid. The initial *p*H value of the solution was adjusted to 6·0–7·0 by the addition of sodium hydroxide. No buffer was used. Twenty-five seeds were placed in each Petri dish and the dishes were placed in a dark-room at 21·5 ± 0·5° C.

The lengths of roots were measured to the nearest mm. The results were expressed as germination percentages and average length of root, disregarding ungerminated seeds. The latter were considered only for the calculation of the germination percentages. This procedure was chosen because certain treatments, such as irradiation by light of various wave-lengths (unpublished results), seem to influence only the germination percentage, the average length of root of those seedlings that did develop being unaffected. Other treatments, such as the addition of tartaric acids as described below, seem to influence only the average root-length and not the germination percentage.

The three stereoisomeric tartrates and the racemic DL-tartrate proved to have quite different and specific effects on the elongation of cress roots (Fig. 1).

D(+)-tartrate, the naturally occurring isomer, has no inhibitory effect at the concentrations tested.

L(−)-tartrate has little or no inhibitory effect during the first 36 hr. of germination. After 47 hr. L(−)-tartrate shows some inhibitory effect, and at 64 hr. the inhibition is considerable.

Mesotartrate is inhibitory from 36 hr. and onwards, and consistently more inhibitory than L(−)-tartrate. DL-*tartrate*, which is the racemic mixture of D(+)-tartrate and L(−)-tartrate, was slightly stimulatory at low concentrations. At higher concentrations, it proved, unexpectedly, to be more inhibitory than the L(−) form given alone, and at the highest concentration even more inhibitory than the mesotartrate.

These effects might be related either to the metabolism of natural organic acids in the plant or to the action of growth substances, or to both. A discussion of the results must, however, be postponed until further evidence has been obtained.

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'Recurrence' of *Macroderma gigas* Dobson

IT is now fifty-eight years since E. R. Waite[1] employed the above title to record what he believed to be the second specimen of this bat, remarkable alike for being the largest member of the suborder Microchiroptera, for its carnivorous habits and for grotesque appearance. Waite's specimen came from the Pilbarra district of the North Western Division of Western Australia, 1,600 miles from the locus of Dobson's type, and provided an enormous extension of range; but he overlooked the fact that the species had been obtained in the Macdonnell Ranges of Central Australia in 1890 and again in 1894.

Since Waite wrote, a belief in the great rarity of the species and its near extinction has grown and has been fostered in popular writing by dwelling upon the abundance of its mummies in caves of the arid north of South Australia. These relics, however, are probably in large part sub-fossil, and recent field work has tended to show that the living animal is much more numerous and widespread than was believed. Tate[3] in 1948 obtained a series at Johansen's Caves near Rockhampton in coastal Queensland, near Olsen's Caves which had yielded it twenty years before, and Douglas[3], Robinson[4] and Ride, W. D. L. (personal communication), have shown that it persists in at least three localities in the North West and West Kimberley Divisions of Western Australia. I am now able to add three new sites in the Northern Territory: (1) the tableland scarp in the Macallum Creek area at about lat. 13° 16′ S. and long. 130° 44′ E.; (2) caves on the Field River near the eastern edge of the Arunta desert at about lat. 23° 34′ S. and long. 137° 53′ E.; (3) the Ellery Creek gorge in the James Range at about lat. 24° 5′ S. and long. 132° 49′ E. In addition numerous reports from intermediate localities of 'white flying foxes' drowned in tanks or otherwise destroyed are strongly suggestive of *Macroderma*.

It has been claimed that the chief food of the species consists of smaller bats. I have obtained no new evidence of this from personal observation, and the accounts of the aborigines are conflicting. In some parts of the country they regard this bat with aversion and state that men have been attacked by it on entering its roosts.

The Central Australian material is in close agreement with the type as described and with the desiccated material from South Australian caves; but it may be noted that the general pallor which has earned it the modern vernacular term 'ghost bat' is not an invariable feature. I have examined Queensland specimens in which the dorsal pelage is a deep brownish drab (about Ridgway's 'hair brown') and the ventrum a decided plumbeous in place of snowy white and with a corresponding darkening of integument; the cranial characters are normal.

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A Chimæra of *Alaria* and *Laminaria* found in Nature

A CHIMÆRA of two kelps belonging respectively to *Alaria* and *Laminaria* was recently collected by one of us (M. I.) on May 18, from among a mass of seaweed which drifted ashore in the neighbourhood of the Marine Laboratory for Biological Education, Hokkaido Gakugei (Arts and Science) University, situated at Shirikishinai Village, Oshima Province, in Hokkaido. The frond of this chimæra is formed by the complete lengthwise and lateral adhesion of two half-fronds each representing one of the two quite distinct genera of Laminariales.

Our specimen, unfortunately, has lost its stipe and holdfast; it is 197 cm. in length and 13·7 cm. in width at the broadest portion. The frond is strongly curved inwardly along the margin of the *Laminaria* portion, thus indicating that this portion is markedly inferior in rate of frond-growth in length as compared with the *Alaria* portion. This latter portion is provided with a complete smooth midrib, up to 15 mm. wide and up to 3 mm. thick, and a complete lateral half of the membranous frond, up to 8·5 cm. wide and up to about 0·5 mm. thick, which is sprinkled with cryptostomata. Hairs emerging from the cryptostomata are densely infested with colonies of *Licmophora lyngbyei* (Kütz.) Grunn. In the lower part of the specimen the midrib of the *Alaria* portion coalesces directly with the *Laminaria* portion, whereas in the upper part it is separated from the latter by a narrow membrane representing the other lateral half of the *Alaria* frond (Fig. 1). On the other hand, the *Laminaria* portion is rather narrow—up to 5 cm. wide—and its upper half is reduced to a few scattered remnants attached along the margin of the *Alaria* portion. The *Laminaria* portion is nearly as thick as a normal frond of *Laminaria* growing at the same locality (up to 3 mm. thick near the outer margin where the frond is thickest). It is worth mentioning that the transition from the thin *Alaria* portion to the thick *Laminaria* portion is so smooth that the latter shows a very gradual increase in thickness in a transverse section through the border between the membranous part belonging to *Alaria* and the coriaceous part belonging to *Laminaria*. The zoosporangial sori are borne on both surfaces in the upper part of the *Laminaria* portion near the border between the two parts, in longitudinal narrow patches, 0·1–2·0 cm. broad (Fig. 1). After a further examination of several other characters, the constituents of this chimæra are concluded to be referable respectively to *Alaria crassifolia* Kjellm. and *Laminaria angustata* Kjellm.

Fig. 1. Middle portion of the specimen showing a zoosporangial sorus (*S*) on the *Laminaria* portion

This sort of chimæra derived from two different genera of kelps has hitherto been unknown to science, so far as we are aware. On the other hand, two examples of malformation in *Laminaria* probably due to coalescence of fronds between two individuals of one and the same species have lately been reported from Hokkaido[1]. The origin of the chimæra reported here may be attributable to the lateral coalescence of two postembryonal plants at their damaged margins of the transition zone between the stipe and the frond, where the meristematic tissue for growth in length is situated in both the genera concerned, as in all Laminariales.

The assistance of Y. Ōiwa for photographs and preparations is gratefully acknowledged.

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Zoospore Morphology of the California Strain of *Plasmopara viticola*

Zoospores were obtained from the sporangia of the California strain[1,2] of *Plasmopara viticola* (B. and C.) Berl. and De T. growing in *Vitis californica* Benth. and *V. girdiana* Munson leaves. Germination occurred in distilled water at 10°–16° C. Active suspensions of zoospores were fixed by exposure for 30 sec. to the vapour of a 2 per cent osmic acid solution. Fixation darkened the flagella and permitted them to be measured easily under the light microscope. For electron microscopy the zoospore suspension was fixed, as above, on a 'Parlodion' film covering a 200-mesh electron microscope screen and allowed to dry.

Table 1. Measurements of *Plasmopara viticola* (California Strain) Zoospores

Zoospore body		Flagella	
Length (μ)	Width (μ)	Long (μ)	Short (μ)
10·3	8·6	20·6	12·0
12·0	10·3	17·2	*
10·3	8·6	20·6	*
13·8	8·6	20·6	10·3
12·0	10·3	15·5	8·6
12·0	10·3	20·6	12·0
Mean 11·7	9·5	19·2	10·7

* Too curled to measure

Measurements of the zoospore body and flagella are listed in Table 1. The short flagellum tended to remain coiled whereas the long flagellum remained extended (Fig. 1*a*). Electron micrographs showed cilia of about 1μ in length on the short flagellum (Fig. 1*b*), but never any on the long flagellum. In both flagella long parallel strands of more dense

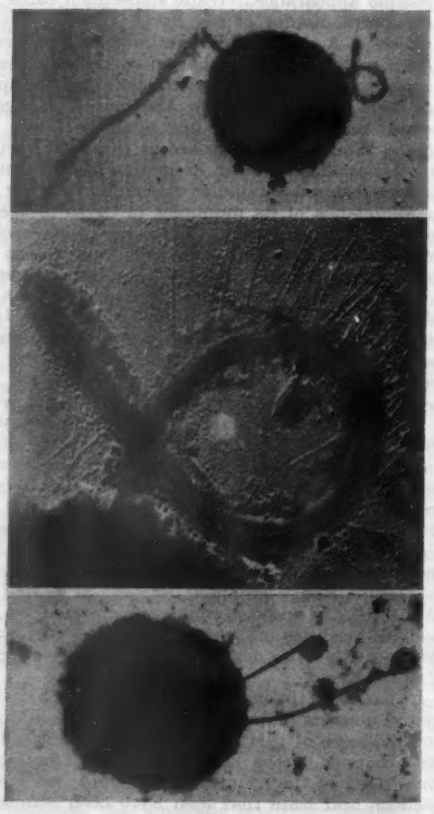

Fig. 1. Electron micrographs of *Plasmopara viticola* (California strain) zoospores and flagella. *a*, Zoospore with long and short flagella. Shadowed with uranium (× 2,030); *b*, short flagellum of *a* at higher magnification showing cilia; shadowed with uranium (× *c.* 14,060); *c*, zoospore with retracting flagella showing terminal 'knobs'; unshadowed (× *c.* 2,200)

material enclosed in a less dense matrix were present (Fig. 1*b*).

The mean dimensions of the zoospore body (Table 1) are similar to those illustrated by Arens[3] for *P. viticola* (13μ × 9·4μ). The inequality in the length of the two flagella has been noted[3,4]; but no figures have been published giving their relative dimensions. In most cases where they have been illustrated no marked difference in their lengths has been shown[4]. The one exception is Arens[3], who illustrates a long flagellum of 41μ and a short one of 26μ. The mean ratio of long to short flagellum, 1·79, is considerably greater than that for Arens's zoospore, 1·58. Lack of comparative data does not allow the attachment of any taxonomic significance to the relative length of the two flagella; however, this may be of importance.

The presence of the 'whiplash and tinsel-type flagella is one of the chief morphological features of the biflagellate series of the Phycomycetes[5]. The possession of these flagellar types by the California strain of *P. viticola* is the first reported for the Peronosporaceae and brings this family into conformity with the lower Peronosporales[6,7].

Zoospores with retracting flagella seen under the electron microscope (Fig. 1*c*) show that the swellings at the ends of the flagella are not the result of coiling as was reported for *Phytophthora infestans*[7]. Even though the long flagellum has retracted to half its normal length, there is no more than a portion of a loop of the dense flagellar core in the terminal swelling or 'knob'. Apparently, as the flagellum retracts the dense internal structure disintegrates and the disorganized material collects in the enlarging swelling.

I wish to thank Dr. Herbert Gold, of the Department of Plant Pathology, University of California, Berkeley, where this work was done, for help with the electron microscopy.

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Behavioural Changes in Animals after Intracisternal Injection with Adrenocorticotrophic Hormone and Melanocyte-Stimulating Hormone

A FEW pharmacodynamic effects of adrenocorticotrophic hormone do not stem from its adrenocorticotropic properties[1,2]. The crisis of muscular hypertonus (acts of stretching) observed in dogs, cats, rabbits and rats injected intracisternally with small doses of this hormone are probably another example of pharmacological effects independent of its adrenocorticotropic properties. Although the behavioural changes following the intracisternal injection of many other hormonal preparations were investigated, the modification of muscular tonus mentioned above is obtained only with small doses of adrenocorticotrophic hormone or melanocyte-stimulating hormone. The term intracisternal injection indicates the replacement of liquor drawn from the cisterna magna with saline in which the various drugs under investigation are dissolved. The volume of these injections never exceeded 2 ml. in dogs, 1 ml. in cats and rabbits and 0·1 ml. in rats. The *p*H of the injected solutions was made as close as possible to physiological values.

Table 1. STRETCHING CRISIS FOLLOWING INTRACISTERNAL INJECTION INTO DOGS

Substance	Source	Dose	Animals with stretching crisis/treated animals
Adrenocorticotrophic hormone	*a*	0·12 I.U./kgm.	26/26
Adrenocorticotrophic hormone	*a*	0·06 I.U./kgm.	0/2
Melanocyte-stimulating hormone	*b*	0·01 mgm./kgm.	11/11
Melanocyte-stimulating hormone	*b*	0·005 mgm./kgm.	8/9
Melanocyte-stimulating hormone	*b*	0·003 mgm./kgm.	2/10
STH	*c*	1 mgm./kgm.	0/3
Thyroid-stimulating hormone	*d*	3 I.U./kgm.	0/2
Total post-hypophysial preparation	*e*	0·25 mgm./kgm.	0/3
Oxitocin	*f*	3 I.U./kgm.	0/3
Chorionic gonadotropin	*g*	0·5 mgm./kgm.	0/2
Pregnant mare serum gonadotropin	*g*	0·5 mgm./kgm.	0/2
Insulin	*h*	1 I.U./kgm.	0/4

Sources: (*a*) Cibacthen Ciba; (*b*) beef preparation 732179 *A* Armour (5 × 10³ U./gm.); (*c*) Armour, lot 369–766, no adrenocorticotrophic hormone activity; (*d*) Ambinon Organon; (*e*) Postipofisan Richter; (*f*) Horm; (*g*) Vister; (*h*) Allen and Hanburys.

From Table 1 it can be seen that in the dog these two hormones were the only ones to induce the peculiar crisis of increasing muscular tonus spreading to many different muscular groups and resulting in a generalized act of stretching. In the dog the stretching crisis, illustrated in Fig. 1, appears within 1–2 hr. after the intracisternal injections as a recurrent series with intermissions of complete recovery and normal muscular tonus. 4–5 hr. after the injection not only does the crisis persist but the time between subsequent stretching acts becomes shorter and shorter so that the onset of one overlaps the end of the preceding one. This lasts for 24 hr. and more, ending with complete recovery. This phenomenon appears strictly dependent on the method of administration, for the infusion of comparatively large amounts of melanocyte-stimulating hormone (1 mgm./kgm.) into the common carotid artery is ineffective.

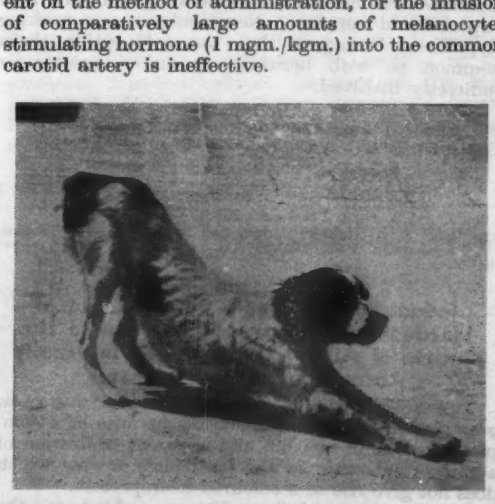

Fig. 1. Typical stretching crisis in a dog intracisternally injected with melanocyte-stimulating hormone

Stretching crises may also be seen in cats, rabbits and rats under the same conditions. However, a few characteristics may help in differentiating the symptoms caused by the two hormones in different animal species. When melanocyte-stimulating hormone is injected into the cisterna magna of rabbits a short period of convulsions precedes a state of catatonic-like stupor. Within 1 hr. the latter is interrupted by a stretching crisis often accompanied by yawning. A complete recovery occurs within 4–5 hr. Catatonic-like stupor occurs in rats, together with scratching movements of unusually long duration. In cats the stretching crisis follows a period of either drowsiness or catatonic-like stupor. Other symptoms may be associated with the intracisternal injection of these two hormones. It is important to mention that neither rectal temperature (in rabbits) nor blood-reducing substances (in dogs) vary. In dogs eosinopænia and ptyalism and in rabbits a slight arterial hypotension may occur.

The liquor drawn while the behavioural changes are in progress does not cause either the isolated guinea pig ileum or the isolated rat uterus to contract. Nevertheless the same liquor if injected intracisternally to another dog evokes the symptoms described above. In the latter case the latent period is not shortened as one would expect. The latent period lasts longer after injecting either hormone into the lumbar subaracnoidal space of dogs, but the symptoms remain unchanged.

Since in dogs adrenalectomy does not curtail the muscular hypertonus caused by intracisternally injected adrenocorticotrophic hormone, this effect cannot be due to its adrenocorticotropic activities. Moreover in dogs the intracisternal injection of a number of drugs causing eosinopænia (histamine, 0·1; 48/80, 1; serotonin creatine sulphate, 0·1; l-epinephrine, 0·02; l-ephedrine, 2; *d*-amphetamine, 1; mgm./kgm.) is not followed by behavioural changes similar to those described above. Finally, chlorpromazine and reserpine injected into the cisterna magna of dogs do not evoke a stretching crisis.

The possible explanations of the mechanism of this pharmacological activity of adrenocorticotrophic hormone and melanocyte-stimulating hormone lack experimental support. Nevertheless as a working hypothesis I suggest that the polypeptide chain common to both hormones is either directly or indirectly involved.

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Induction of Melanin Patterns and of Hardening as Separate Processes in the Cuticle of Albino Locusts with Internally Absorbed Phenol Substrates

The cuticle of the albino strain of *Schistocerca gregaria* is more or less colourless because of a complete absence of melanin and apparent utilization of a phenol substrate in the hardening process which does not give rise to a coloured scleroprotein.

When protocatechuic acid was added to the hæmolymph, the extra-embryonic liquid system, or the yolk system of an albino, it was significant that it did not give rise to a coloured quinone–protein substance. On the other hand, dihydroxyphenylalanine and catechol did. These two latter phenol substances, however, failed to do so when phenylthiourea, a blocking agent of tyrosinase, was also added.

In view of a phenolase enzyme being present in the albinos, it seemed likely, therefore, that the introduction of different phenol substrates into their hæmolymph and tissues might lead to changes in the cuticle. Injection techniques, however, incur numerous disadvantages[1–4], and in this case they would be liable to invalidate at once any results that might be obtained.

An immersion technique was therefore carried out as follows. The wax layer of the epicuticle of the last few segments of the abdomen of albino nymphs was first removed by rubbing it off with cotton wool soaked in chloroform. An albino thus treated (from now on referred to as a 'dewaxed' albino) was then placed in a ring of 'Plasticine' fixed to the rim of a test tube so that the dewaxed end of its abdomen was dipped below the surface of the phenolic solution to be tested. Solutions of tyrosine, catechol, dihydroxyphenylalanine and protocatechuic acid of *N*/20 strength were used. Controls consisted of using albinos with their wax coating untouched and 'dewaxed' albinos either dipped in saline, or simply suspended in air. The test albinos were kept in position for periods ranging from 24 to 48 hr.

'Dewaxed' albinos dipped in catechol or tyrosine, as just described, developed a pattern of brown to black pigment in their cuticles. This pigment could not be removed with acid–methanol, ethyl alcohol or acid–ethanol, which showed it to be melanin[5]. Catechol, however, was responsible for a far more intense and extensive pattern than tyrosine. This pattern first developed in the dorsal region and posterior margins of the cuticular plates of the abdomen; it then spread forward to the thorax and the head and the colour slowly intensified. Moreover, the pattern laid down resembled that of the normal strain of the same insect. The controls remained unaltered, and from this it is evident that when the 'dewaxed' albinos are suspended in a phenol solution with only the dewaxed end of the abdomen below the surface, the phenol substance passes through the dewaxed cuticle of the end of the abdomen into the hæmolymph and tissues and forward to the head region where the melanin pattern is relatively well developed.

When solutions of protocatechuic acid and dihydroxyphenylalanine were used, melanin was not deposited in the albino cuticle. In the light of other work[6], this is surprising in the case of dihydroxyphenylalanine. An examination of sections of the cuticles of albinos treated with these two substances, however, revealed that extra hardening had taken place; the outer region of the albino cuticle, normally colourless, had been tanned to an amber colour. When catechol was used, the melanin deposits were also confined to the outer region of the cuticle. It was most significant, however, that the catechol had not caused the cuticle to turn amber colour where melanin had not been deposited. Catechol, therefore, seemed to be exclusively concerned with melanization and protocatechuic acid and dihydroxyphenylalanine with sclerotization.

The results therefore show, first, that the immersion technique described demonstrates that phenol substrates originating in the hæmolymph and tissues of

an insect must reach the outer region of the cuticle before they can be oxidized in the presence of an activated phenolase. Secondly, that melanization and hardening can be induced to take place as separate processes utilizing different substrates. Thirdly, that catechol is exclusively concerned with melanization, and protocatechuic acid and dihydroxyphenylalanine with sclerotization.

We are as yet uncertain why dihydroxyphenylananine was not also utilized for the formation of melanin, as it is supposed to do[6]. However, in view of the recent finding of catechol in insects[7], it is likely, on the basis of the results reported here, that it could be a natural substrate for melanization in insect cuticles.

Work on this problem is still in progress and it is hoped to publish a fuller account in due course.

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Distant Hybrids from Parents with Reduced Immunological Reactivity

If they hatch out at all, there is usually a high incidence of malformation in hybrids between guinea fowl hens and domestic fowl cocks[1–3]. Adult hybrids have been described only twice[4,5].

I wished to verify whether a distant cross of the above combination was favourably influenced by a decrease in the reciprocal immunological reactivity of both the parent birds. The results support this assumption, as I obtained four hybrids which have survived into maturity.

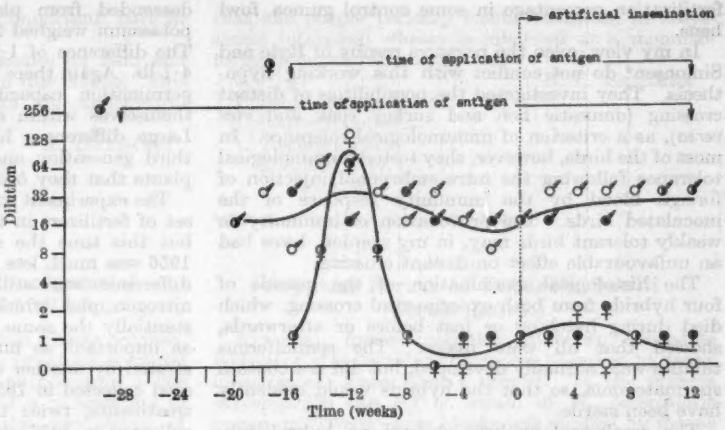

Fig. 1. Course of mean agglutinin titres in four parent birds in both experimental crossings

Procedures influencing the immunological reactivity of experimental animals (decrease of antibody production to erythrocytes of the other parent species—Fig. 1) and results of subsequent crossing using artificial insemination are compared in Table 1 with my own control results and those of other authors. The fertilization percentage in both experimental crossings far exceeds that of the control guinea fowls. Surprisingly, 4 of the 9 hybrids which hatched out have survived into maturity; they are now 14–16 months old.

In the control hens, as distinct from the experimental birds, the fertilization percentage displays a high degree of individual variability (11–74 per cent). In order to stabilize the frequency ratio n/N (n = number of fertilized eggs, N = number actually laid), the transformation of the random variate was used and Student's test was afterwards applied. Although the test cannot be regarded as absolutely conclusive in the present case, it nevertheless is almost significant at the 5 per cent level ($P < 0.05$). It appears, therefore, that the results can be ascribed to the measures described above. In view of the high individual variability, a larger number of parent birds should be used in future work, and an attempt should be made to determine the cause of a high

Table 1. Results of Distant Crossing

Crossing	Number of:				Percentage to previous columns		
	Eggs		Chicks		Fertilization	Hatching	Survival to maturity
	Laid	Fertilized	Hatched	Survived to maturity			
Control (ref. 1)	89	10	0	0	11·2	0	0
Control (ref. 2)	201	16	1	0	8	6	0
Control (ref. 3) (2 ♀, 2 ♂)	96	20	3	0	21	15	0
Control (5 ♀, 2 ♂)	83	41	1	0	49	2	0
2 ♀, long-term administration of fowl blood during maturity (1·0 ml. three times a week)							
1 ♂, intra-embryonal injection of guinea fowl blood (0·2 ml. on the 11th day of incubation) + long administration of guinea fowl blood from birth	67	52	7	3	78	13	43
4 ♀, controls							
2 ♂, intra-embryonal injection + long-term administration of guinea fowl blood from birth*	76	67	2	1	88	3	50

* One of these two males is the same as that in the preceding cross.

fertilization percentage in some control guinea fowl hens.

In my view, even the negative results of Ryle and Simonsen[6] do not conflict with this working hypothesis. They investigated the possibilities of distant crossing (domestic hen and turkey cock and *vice versa*), as a criterion of immunological tolerance. In most of the birds, however, they tested immunological tolerance following the intra-embryonal injection of foreign blood by the immunity response of the inoculated birds. The provocation of immunity in weakly tolerant birds may, in my opinion, have had an unfavourable effect on distant crossing.

The histological examination of the gonads of four hybrids from both experimental crossing, which died during hatching or just before or afterwards, showed that all were males. The seminiferous tubules were normally developed, but did not contain spermatogonia, so that the hybrids would evidently have been sterile.

The serological analysis showed no hybrid substance[5,7] in our hybrids apart from the common and specific antigens for both parent species.

I thank Mr. V. Matoušek, of the Institute of Hygiene and Occupational Diseases, for carrying out the statistical analysis.

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Environmental Conditioning of Flax

Experiments carried out over a number of years have shown that remarkably large differences can be produced in the weight of flax plants as a result of the effect of the environment on previous generations of plants. In one experiment, all eight combinations of nitrogen, phosphorus and potassium fertilizer treatments were applied to forty plants of an inbred, self-fertilizing variety in the damp, dull season of 1954. The progeny, which were grown under a uniform set of fertilizer treatments, were cut at ground-level at maturity and weighed. The differences in the weights of the progeny (C_1 1955) due to the parental treatments are shown in Table 1. Some types are as much as two and three times the weights of others and, with the exception of the nitrogen plot, they are closely correlated with the weights produced by applying the fertilizers directly to the plants (Table 1, C_0 1955).

The differences were undiminished in the second generation grown in 1956 (C_2 1956), although the seed obtained from the first generation was of the highest quality in weight, appearance and germination, and the C_1/C_2 correlation was virtually complete ($r = 0{\cdot}97$). In another test on the second generation grown in 1956, 960 plants descended from plants receiving nitrogen and potassium two generations earlier weighed 0·85 cwt., and an equal number descended from plants receiving phosphorus and potassium weighed 2·63 cwt.—three times as much. The difference of 1·78 cwt. had a standard error of 4·1 lb. Again there was no difference in seed weight, germination capacity or energy, and the plants themselves within each type were highly uniform. Large differences have also been observed in the third generation and there is evidence from young plants that they occur in the fourth generation.

The experiment was repeated by applying the same set of fertilizers in the warm, sunny season of 1955, but this time the effect on the progeny grown in 1956 was much less (Table 1, C_1 1956), although the differences were still significant and, apart from the nitrogen plot which was exceptional before, substantially the same. Evidently seasonal factors are as important as nutrition. This was also demonstrated by another experiment in which plants from seed collected in 1955 were, for comparable fertilizer treatments, twice the weight of plants from seed collected in 1956, when the two sets of plants were grown together in 1957.

Table 1. Weight in lb. of Eighty Plants. $s.p. \times t$ = Least Significant Difference for $P = 0{\cdot}05$

	NPK	NP	NK	N	PK	P	K	Nil	$s.p. \times t$
C_0 1955	11·4	11·8	4·4	0·1	9·6	10·4	8·9	7·3	3·3
C_1 1955	11·1	9·5	3·7	12·1	11·3	8·4	7·3	5·9	1·2
C_2 1956	17·5	15·9	6·5	18·7	15·5	14·2	12·4	8·1	3·3
C_1 1956	11·6	9·2	8·2	7·3	10·9	9·3	8·2	8·2	2·2

The inheritance of such large differences to at least the fourth generation is likely to be due to cytoplasmic change rather than to maternal effects, and this is supported by other experiments. (i) Plants were grown from seed from capsules collected at varying stages of ripeness. Plant weight increased logarithmically with decrease in seed weight to the limit where the seed was so small that no germination occurred. (ii) Forty plants of two conditioned types which were reciprocally grafted retained their identity in both stock and scion. (iii) Reciprocal crosses between two conditioned types resembled the female parents more than the male, but there was also clear evidence of transference of effect through the pollen in both directions. (iv) The conditioned types do not produce the same relative dry weights when grown in the field in the summer as in a warm greenhouse under the lower light intensity and shorter day of winter. Presumably the types are adapted to different environments.

One of several reasonable hypotheses which can be put forward at this stage is that, with relatively high temperature and low light intensity, cell division can proceed rapidly; but the number of cytoplasmic self-duplicating particles falls, due to a shortage of photosynthetic products, the utilization of these products being also influenced by mineral supply. The altered cytoplasm stimulates the nucleus to synthesize different substances, or different amounts of the same substances, to establish a new equilibrium between nucleus and cytoplasm. The new equilibrium could be at least as stable as the old, and the new plant type to which it gives rise would have the appearance and constancy of a distinct genotype. Such a cytoplasmic – nuclear interaction may further simulate genetic change by the nuclei themselves having an effect on the difference between reciprocal crosses of environmentally conditioned types, the pollen nucleus complementing any small effect of the pollen cytoplasm. In short, plants may remain differentiated as a whole over several generations in addition to the normal differentiation of parts of plants within a generation. Temperature/light

relations will probably play an important part in further investigations.

A detailed account of these studies on flax, and on other organisms, will appear in due course. This work was aided by a grant from the Agricultural Research Council.

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'Purple Pericarp': a Monofactorial Dominant in Tetraploid Wheats

A NUMBER of varieties of tetraploid wheats originating from Abyssinia have purple- or violet-coloured grains, due to the presence of an anthocyanin in the cells of the pericarp. As part of a programme of hybridizations undertaken for the production of tester stocks carrying useful marker genes, a white-grained eligulate variety of *Triticum durum* Desf. (from Cyprus) was crossed with a purple grained variety from Abyssinia, *T. durum* var. *arraseita* Hochst. (=*T. dicoccum* var. *arraseita* Perc.). Although the F_2 family raised was only small, it is felt that the results should be put on record because they indicate that the purple pericarp colour is inherited as a simple monofactorial dominant.

The F_1 plants, when allowed to mature normally (Table 1), bore purple grains like the male parent. Of 44 F_2 plants harvested, the ears of 28 bore purple grains, 12 ears had non-coloured grains and 4 could not be classified owing to discoloration, immaturity, etc., of their grains.

Table 1

Grains	Observed (O)	Calculated (C)	Deviation ($O - C$)	$\frac{(O-C)^2}{C}$
Purple	28	30	− 2	0·13
Non-coloured	12	10	+ 2	0·40
Total	40	40	0	0·53

With $\chi^2 = 0{\cdot}53$, for 1 degree of freedom, $P = 0{\cdot}5$–$0{\cdot}3$, showing a good agreement with a 3 : 1 ratio.

The only relevant report in the literature appears to be that of Caporn[1], who studied the progeny of a cross *T. polonicum* × *T. durum* var. *arraseita* ('*T. eloboni*') made by Biffen. In this case the F_2 consisted of 28 plants with fully purple grains, 8 with the colour restricted to longitudinal streaks and 136 with non-coloured grains. In the F_3, some of the non-coloured grained plants gave streaked grained plants and non-coloured grained ones.

Although Caporn's puzzling results may perhaps be due to the introduction of additional factors affecting pericarp colour from the *T. polonicum* parent, it is felt much more likely that the streaked and impure non-coloured grained plants resulted from a shading effect of the closely investing long glumes caused by the *polonicum* gene or genes. In support of this possibility, it should be mentioned that although the ears of the F_1 plants of the present cross normally bear purple grains as noted above, it was observed that if the ears are enclosed in black paper while maturing, only non-coloured grains are produced.

Hence, in the light of the results now presented, and despite the observations of Caporn, it is suggested that the purple pericarp colour occurring in Abyssinian tetraploid wheats is inherited as a monofactorial dominant character.

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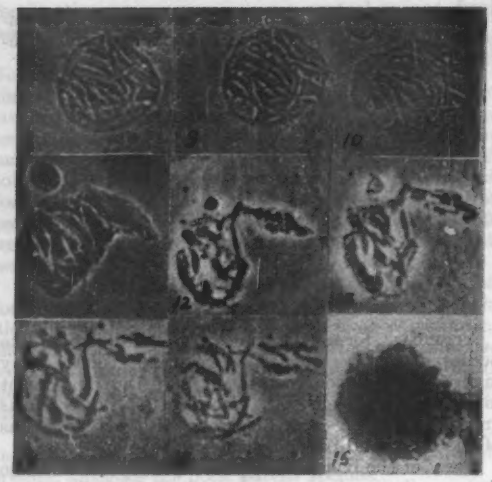
Atypical Forms of Tubercle Bacilli (Strain *B.C.G.*)

ATYPICAL forms (granules, globules, spore-like bodies) of *M. tuberculosis* have been observed by many investigators since Koch's time[1–3]. In the present investigation the *B.C.G.* strain of *M. tuberculosis* grown on 'Tween'–agar blocks was studied by means of the light- and phase-contrast microscope.

Many of the bacilli multiplied by simple transverse fission. Some, however, branched into filaments. Granules appeared in these forms: in some instances a sufficient number of granules appeared to fill the entire rod (Fig. 1). The granules increased in size. Some which measured 0·2μ in diameter when first seen were 1–3μ or more in diameter (Fig. 2). Other

Figs. 1–7. Phase-contrast photographs. (× 1,400)



Figs. 8–15. Serial photographs of a developmental process over a period of 70 days. At the beginning, 8, 9 and 11 were taken in a bright field. 16, photograph of a hydrochloric acid/fuchsin stained smear. (× 1,400)

granules looked like empty rings and resembled spores (Fig. 3). Besides angular bodies arising from the fusion of single rods (Fig. 5), a considerable number of free globules could be observed (Fig. 4), more or less similar to large bodies or protoplasts of Enterobacteriaceae[10–11], and also protoplasts of aerobic spore-forming bacteria[12].

It was considered important that granules and globules of different sizes may arise from the conjugation of two or more individual rods (see arrows in Figs. 2, 6). Conjugation of rods without the subsequent formation of globular bodies, as previously described[9], was also observed (Fig. 7).

In some instances the 'large bodies' could be seen to break into rods (Figs. 8–15). Although this alone would point to their abundance in nuclear material, the application of different nuclear staining methods seems to confirm this point (Fig. 16).

The assumption that in the process of fusion of different rods into large bodies, genetic material might be assembled, and that their breaking up into rods would result in a redistribution of this material, makes further investigations necessary.

We are indebted to Dr. S. Vas, McGill-Montreal General Hospital Research Institute, for his valuable advice in microphotography.

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Strain Sensitivity of Albino Rats to Reserpine

During work on the effects of reserpine on chromaffin tissue, it became apparent that albino rats of Sprague–Dawley and Wistar strains differed markedly in their sensitivity to reserpine. This phenomenon has been investigated by observing the loss of catechol amines by the adrenal medulla in response to intravenous injections of 1, 5, 10 and 15 mgm./kgm. of the drug.

Male rats weighing 200–250 gm. (Wistar) or 250–300 gm. (Sprague–Dawley) were used in groups of 8 or 10. 24 hr. after an injection of reserpine the animals were killed by a blow on the head. The adrenal glands of two animals were fixed after bisection in either formol–dichromate (neutral formalin 10 per cent, potassium dichromate 3 per cent) or potassium iodate followed by 10 per cent formalin[1]. Dichromate-fixed material was embedded in paraffin wax and sectioned at 6μ. Material treated with iodate was sectioned at 35μ on the freezing microtome. Some sections were examined unstained, others were counterstained with either hæmatoxylin or sudan black. The remaining adrenal glands obtained from each group of animals were pooled and weighed: pressor amines were extracted[2], purified on alumina[3], and assayed by the method of Euler and Hamberg[4].

The results are summarized in Tables 1 and 2. A positive chromaffin reaction is given by cells which contain either adrenaline or noradrenaline while a positive iodate reaction is only given by noradrenaline-containing cells[5]. In the present work the results obtained by assay correlate well with the histochemical findings. 5 mgm./kgm. of reserpine administered to Sprague–Dawley strain animals produces the same degree of depletion of medullary catechol amines (almost complete) and the same constitutional disturbances as does 15 mgm./kgm. given to Wistar rats. Doses of 10 mgm./kgm. and more given to Sprague–Dawley animals result in convulsions and death. Constitutional disturbances include drowsiness, lachrymation and diarrhoea.

The degree of catechol amine depletion is dependent upon the dose of reserpine employed. In partially depleted glands the relative proportions of adrenaline

Table 1

Rats	Reserpine (mgm./kgm.)	Chromaffin reaction	Iodate reaction
Sprague–Dawley	0	*G*+++	*P*+++
,,	1	*G*+ or *P*+	*P*+
,,	5	− or *P*+	−
,,	10	Death	
Wistar	0	*G*+++	*P*+++
,,	1	*G*++	*P*++
,,	5	*G*+ or *P*+	−
,,	10	*G*+ or *P*+	−
,,	15	− or *P*+	−

G, Generalized reaction; *P*, patchy reaction.

Table 2

Rats	Reserpine (mgm./kgm.)	Total catechol amine		Noradrenaline (per cent)	Depletion (per cent)
		μgm per gm./adrenal	μgm. per rat		
Sprague–Dawley	0	946	42·0	18	—
,,	1	321	15·0	15	64
,,	5	35	1·5	—	96
Wistar	0	872	28·0	15	—
,,	1	411	21·5	16	23
,,	5	146	8·0	—	71
,,	15	42	1·4	—	95

and noradrenaline remain normal, noradrenaline forming about 16 per cent of the total amine, and there is no evidence of a selective loss of either amine such as occurs in association with insulin hypoglycæmia. Insufficient pressor amine was extracted from glands after injections of 5 mgm./kgm. and more to allow an estimate of the individual amines.

It should be noted that glands removed 24 hr. after an injection of reserpine show an increase in weight as compared with controls. This change is due to cortical hypertrophy and is associated with an increase in the esterase content of the inner part of the zona fasciculata and the zona reticularis. As a result of this change, the adrenals show an abnormally low content of pressor amines if these are given as per gm. of adrenal weight, and it is therefore preferable to give the catechol amine content per rat (providing rats of uniform age and weight are used), or per unit body-weight.

I would like to express my thanks to Ciba Laboratories, Ltd., for supplies of reserpine ('Serpasil').

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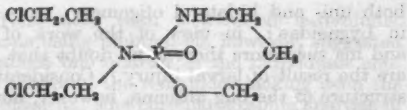
Chemotherapeutic Action of a Cyclic Nitrogen Mustard Phosphamide Ester (B 518-ASTA) in Experimental Tumours of the Rat

The synthesis of new cytostatic drugs is governed by the attempt to find new substances which unite maximum therapeutic effectiveness with minimum toxicity. For this purpose it seems to be advantageous not to apply the substance in its active form, but by introducing suitable chemical groups to transform it into an inert transport substance which will be reconverted into the active form at the site of therapeutic action in the body. This principle has already proved of value in the treatment of prostatic carcinoma with stilbœstrol diphosphate[1].

Using the same method, Friedman and Seligman[2] combined the active *bis*-(β-chlorethyl)amino-group with phosphoric acid. The resulting compounds proved, however, to be therapeutically ineffective. In our experiments we allowed *bis*-β-chlorethyl-phosphamide-dichloride to react with alkanolamines. Thus we obtained cyclic *bis*-(β-chlorethyl)-phosphamide esters with two phosphamide bonds and one ester bond. Chemical analysis has shown that the basicity of the phosphamide nitrogen and thus also the reactivity of the chlorine atoms are considerably reduced. In comparison with *bis*-(β-chlorethyl)amine (nitrogen mustard, HN2), the rate of chlorine ion liberation in aqueous solution (at 37° C.) is considerably lowered.

The examination of the therapeutic effectiveness of numerous homologous compounds in different graft tumours of the rat has shown B 518-ASTA to be particularly effective and well tolerated. B 518 is the experimental designation of the cyclic propanol-amido-ester of *bis*-(β-chlorethyl)-phosphamide. Its trade name is 'Endoxan R', Asta-Werke A.G., Brackwede (Germany).



The minimum lethal dose of B 518 in the rat is 160 mgm./kgm., whereas for N-oxide mustard the minimum lethal dose is only 50 mgm./kgm., and for nitrogen mustard even as low as 1·5 mgm./kgm. Thus the toxicity of B 518 is remarkably low.

In therapeutic trials on fully developed tumours of the rat, for example, the solid Yoshida sarcoma (20 gm.), Walker-256-carcinoma (1 gm.) and Jensen sarcoma (5 gm.) we obtained a definite cure with a single intravenous injection of B 518. The medium effective dose (*DC*50) was found to be 3·9 mgm./kgm. for the Yoshida sarcoma, 6·0 mgm./kgm. for the Walker carcinoma and 3·6 mgm./kgm. for the Jensen sarcoma, that is, it amounts to only 2–4 per cent of the minimum lethal dose. Thus the therapeutic index of B 518 is more than twice as wide as that of N-oxide mustard and about 10 times as large as that of the ethylenimines such as TEM, TSPA and *E* 39-BAYER. In addition, B 518 proved to be the only substance which considerably inhibited the DS-carcino-sarcoma previously resistant to all other compounds[3].

In vitro tests, in which B 518 was incubated with tumour cells at 37° C., showed complete inertness of the compound up to a concentration of 10^{-3} gm./ml., the cells being then grafted on to healthy young rats and their taking capacity checked. This makes it appear probable that the cyclic propanol amide ester of *bis*-(β-chlorethyl)-phosphamide actually represents an inert transport form, from which the highly active form is liberated only within the body.

The results will be published more fully in further papers[4].

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'Compensatory Hyper-regeneration' in the Antennæ of Hemiptera

Wolsky[1] claims that prior to his 1957 demonstration, under the above title, there was no experimental evidence to show that the antennal oligomery frequently encountered in Hemiptera Heteroptera results from the unusual course regeneration takes after larval injury. But in 1829 Heineken[2] amputated the antenna of a reduviid larva and obtained an adult exhibiting just those features which Wolsky now notes. Gäbler[3] studied antennal regeneration in three families of Heteroptera, and Balazuc[4], unaware of Gäbler's work, has given a full account of regeneration in a reduviid. In addition, the literature abounds with references to the field occurrence of

both uni- and bi-lateral oligomery, more especially in Lygaeidae: in view of the work of Heineken and his successors there is no doubt that such cases are the result of larval injury. Consideration of the structure of the bug antenna, however, now suggests that analysis of the experimental results can be taken one stage further.

It has been pointed out that if amputation takes place sufficiently early in larval life then the adult antenna is shorter (and thicker) than normal because, while each 'segment' regenerates to a length greater than usual, there is always one 'segment' less than in the normal adult (except, of course, when only part of the distal 'segment' has been removed)[4]. Now consideration of the bug antenna shows it to comprise a basal scape, a pedicel (bi-annulate in Pentatomoidea) and a bi-annulate flagellum[5]. From the observations of earlier workers, including Wolsky, it is apparent that whereas a regenerated lygaeid or reduviid antenna has three 'segments', that of a pentatomoid has four: this suggests that in each case there is anarthrogenesis within the flagellum. As the articulation between flagellum and pedicel differs from other antennal articulations—the pedicel–flagellum articulation forms part of a proprioceptive organ—examination of oligomerous individuals and identification of the annuli presents no difficulties[6]: inspection of many oligomerous Lygaeidae and Pentatomoidea confirms that in every case there is but a single flagellar annulus.

It is concluded that when an antenna is amputated anywhere between the base and the intra-flagellum articulation, a bug larva will regenerate an antenna more or less shorter than normal—depending upon the time and instar at which amputation is carried out and upon its site—but always without forming an articulation within the flagellum. It follows that the factor responsible for arthrogenesis within the flagellum is dissociable from the factor controlling length of regeneration and is present only in the embryo (or is inhibited during regeneration).

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Inaccuracies of Anaphase Estimation of Radiation-induced Chromosome Exchange

Wolff and Luippold[1] have demonstrated that analysis of metaphase aberrations and of anaphase bridge frequencies gives qualitatively different radiation dose curves, and directed attention to discrepancies between various results that some have found difficult to accommodate in classical chromosome breakage theory. There seems to me to be a factor ignored in classical theory that may explain some of these discrepancies.

In classical theory, exchanges are produced in numbers proportional to the square of the X-ray dose. Breaks are produced in numbers proportional to dose. At a given dose, D, the probability of an exchange in any one chromosome arm will be αD^2 and the probability of a chromosome break in any chromosome arm will be βD. The probability of an exchange and a break involving the same chromosome arm will be $\alpha D^2 \times 2\beta D$, the factor 2 being introduced because the exchange involves two arms. Now half these coincident breaks will be between the exchange point and one of the centromeres and may effectively prevent an anaphase bridge occurring. The expected number of anaphase bridges will be proportional to $\alpha D^2 - \alpha BD^3$. Better algebra may no doubt be devised, but the essential point will remain that the larger dose will increase the probability that an exchange may be 'undone' by the production of a suitable break.

It seems unlikely that the resulting correction will explain the discrepancy observed by Wolff and Luippold unless the effective breaks adhere in metaphase and separate in anaphase. But it would explain discrepancies between metaphase and anaphase data for chromatid exchanges, and would require some departure from the (dose)^2 law for exchanges at high doses.

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Sex-linked and Sex-limited Mutation of the Fly *Muscina stabulans* (Fall.) (Muscidae)

In a series of papers, Tate[1–4] has described the inheritance and expression of a mutation, white-apricot (*w*), in the blowfly *Calliphora erythrocephala*. He showed that this factor is probably situated in the *X*-chromosome and is recessive to the dominant allele for wild-type eye colour which is located in the homologous section of the *Y*-chromosome in heterozygous males. No evidence was found of crossing-over between *X*- and *Y*-chromosomes in this fly. The object of the present communication is to report a similar case in the fly *Muscina stabulans*.

A few white-eyed females were noticed in a stock of *M. stabulans* which had been started with eggs of an unknown number of females from Johannesburg. The F_1 generation flies from these females were all of the wild-type, but in the F_2 generation white-eyed females again appeared. By breeding from the white-eyed females and males from the same batch, a pure line was eventually obtained in which the females are all white-eyed and the males all of the wild-type. This line has now been maintained for more than twelve generations without a single white-eyed male or red-eyed female appearing. A wild-type line was also selected for, and it has produced no white-eyed females in more than twelve generations.

When white-eyed females were crossed with wild-type males, the F_1 generation was wild-type, but the F_2 generation comprised 79 white-eyed females, 71 wild-type females and 169 wild-type males. When heterozygous wild-type males were crossed with homozygous wild-type females, the resulting F_1 and F_2 generations were both wild-type, but the F_2 generation yielded 43 white-eyed females, 239 wild-type females and 291 wild-type males. These figures support the hypothesis that, in this stock, the mutant gene (*w*) is situated in the *X*-chromosome and that there is a dominant allele (*W*) in the homologous section of the *Y*-chromo-

some ($\chi^2 = 1{\cdot}533$, $P > 0{\cdot}4$ and $\chi^2 = 2{\cdot}058$, $P > 0{\cdot}3$, respectively). Since the heterozygous and homozygous wild-type flies are phenotypically indistinguishable, and since there is no gradation in the expression of the mutant gene, the above explanation of the observed facts seems the most likely. The fact that no white-eyed males were found suggests that crossing-over between the centromere and (*w*) locus is at least very rare or wholly absent.

In the Calyptrata, besides the case of *Calliphora erythrocephala* reported by Tate, white-eyed mutants have been described in the blowflies *Lucilia cuprina*[5] and *Phormia regina*[6]; but in these cases the mutant genes are simple autosomal recessives to the dominant alleles determining wild-type eye colour. It would be interesting to have information on the location of eye colour genes in other members of the Calyptrata.

I am indebted to Dr. D. Nolte, of the Department of Zoology, University of the Witwatersrand, for reading this communication.

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Niobium in Ascidians

It has been known since 1911[1] that the blood of certain species of ascidians contains organically bound vanadium. Bertrand[2] has shown that most marine invertebrates contain between 0·2 and 2 parts per million of vanadium dry weight, whereas in ascidians the figure may be as high as 6,500 p.p.m. dry weight. This high level is not, however, true of all species, and in some families the level, where investigated, is not significantly above that found in other groups of marine invertebrates. *Didemnum candidum*, for example, is quoted as containing 2·6 p.p.m.

In the course of some other work I was led to the conclusion that some of these species of ascidians may possibly contain niobium in place of, or in addition to, vanadium. This has in fact proved to be correct. Preliminary analyses have kindly been made for me by the Chemical Research Laboratory of the Department of Scientific and Industrial Research, using spectrographic methods. These analyses have been supplemented by the use of chromatographic methods in the Plymouth Laboratory. By these methods the flesh of *Mytilus edulis* was shown to contain 0·22 p.p.m. of vanadium dry weight and less than 0·001 p.p.m. of niobium. *Phallusia mammillata* (a species of ascidian with known high vanadium content) had 1,260 p.p.m. of vanadium dry weight in the flesh (compared with 1,700 p.p.m. found by Webb[3]), while niobium was not detected (that is, less than 0·001 p.p.m. dry weight). In *Molgula manhattensis* both vanadium and niobium were detected. Expressed in p.p.m. dry weight, the vanadium content of the test of *Molgula* was 16, of the flesh without the test 101, and of the whole body 54 (compared with 31·8 given by Bertrand[2]); the niobium content of the test was 1·9, of the flesh without the test 56, and of the whole body 26·5. These figures were based on analyses carried out on pooled material from more than a hundred individuals. Investigations using niobium-95, however, suggested that only about one quarter of the individuals contained any niobium, the remainder lacking even the ability to ingest it. The chromatographic analysis of single individuals confirmed this: all individuals contained either vanadium or niobium, but there was no detectable niobium in animals which had significant vanadium, while only traces of vanadium could be detected in animals with detectable niobium. In the former group the vanadium content ranged from 29 to 98 p.p.m.; in the latter the vanadium content was less than 2 and the niobium content 25–75. The niobium appears to be organically bound.

If, as has been suggested, the vanadium present in petroleum deposits is derived from ascidians, it seems likely that these may also be the source of the niobium which is likewise present in these deposits.

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Rearing Newts in the Laboratory for Experimental Purposes

I have always considered the methods employed in the rearing of newts in the laboratory as too time-consuming. The newts are generally maintained in finger bowls; the water is usually changed once a day, and during the summer months a cool room is required, or the water is changed several times a day.

My aquarium was designed to eliminate these difficulties. It consists of a sheet metal tank 6 in. high and divided into compartments. Small holes are cut in the partitions so that the water can flow freely. A fine mesh screen is welded on the bottom of the partition so that the newts cannot crawl from one compartment to another. One end of the aquarium rests above a sink and the water is piped in at the opposite end. An overflow pipe regulates the level of the water at 3 in., and the diameter of the overflow pipe is at least twice that of the inflow pipe. A large pipe at bottom-level is used for draining the aquarium, which need be done only two or three times a year.

A free area 1½ in. wide is provided at each end of the tank by making the partition 3 in. less than the length of the tank. This prevents the newts escaping through the overflow or inflow pipes. The tank can also be drained without removing the newts. The inflow pipe enters the tank at about 4½ in., which is 1½ in. above the water-level, making it easy to observe the amount of water flow.

The compartments are 6 in. × 8 in., and there are 15 of them in the present model. Since the water flows constantly, more newts can be placed in each compartment than in a non-flow container of equal size. The largest number that have been reared in each compartment is twelve.

Each compartment contains a liberal supply of floating water plants, such as *Elodea* (*Anacharis*), *Lemna* (duckweed), *Riccia* and several snails. Five sections of clear glass cover the aquarium so that the plants receive adequate light. Since the glass is in sections, newts can be removed with long

forceps from a compartment without uncovering more than three compartments. A screen covering tends to shade the plants, preventing them from thriving.

It has not been necessary to use biological water. Newts do equally well in tap water, and I have raised them in the city water of New York City and Chicago.

Most investigators who employ newts feed each one individually by offering it meat with a pair of forceps; this occupies considerable time. I find that if small pieces of ground muscle are placed in the water once a week the newts will eat readily; only 10–15 min. a week is then required to feed a hundred or more newts.

By employing the principles of the aquarium described above, many more newts can be studied at less expense of time and money than by the methods generally used.

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Chicago 12, Illinois.

Release of Phosphate from Soil Minerals by Hydrogen Sulphide

In this laboratory it was observed that some colonies of soil bacteria and fungi, grown on carrot-extract agar containing 0·1 per cent ferric phosphate in suspension, turned the particles of phosphate in their vicinity black. Blackening occurred only when hydrogen sulphide was produced by these organisms, some of which formed it anaerobically but others aerobically. Bromfield[1] showed that hydrogen sulphide was produced by several strains of *Bacillus megaterium* in apparently well-aerated soils. These results suggested that sulphides in soil may reduce ferric phosphate to black ferrous sulphide and release available phosphate.

The influence of 24-hr. treatment with hydrogen sulphide at room temperature was determined on phosphates of ferric iron (isomeric with meta-strengite) of calcium (hydroxy apatite, octa phosphate and a trace of brushite) and of aluminium (amorphous by X-ray analysis), and also on ferric and calcium phytates.

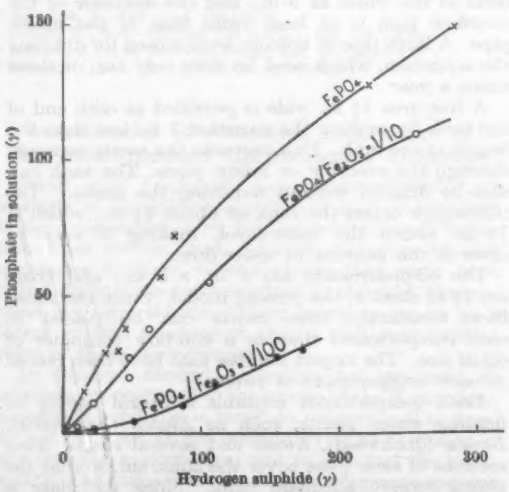

Fig. 1. Release of phosphate from ferric phosphate by hydrogen sulphide in the presence and absence of iron oxide

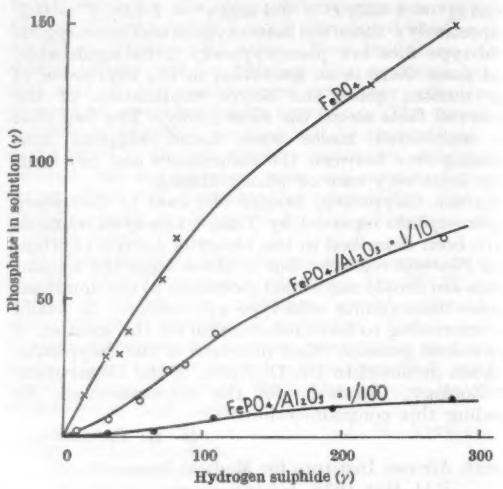

Fig. 2. Release of phosphate from ferric phosphate by hydrogen sulphide in the presence and absence of aluminium oxide

Phosphate was released from ferric phosphate by much lower concentrations of hydrogen sulphide than from tri-calcium and aluminium phosphates or from ferric and calcium phosphates. It was considered that most soils would not contain sufficient hydrogen sulphide even under anaerobic conditions to attack any phosphate other than ferric phosphate. Since most soils contain sesquioxides which might compete with ferric phosphate for any hydrogen sulphide formed, additional treatments were included to test the effect of hydrogen sulphide on ferric phosphate mixed with either iron oxide (hæmatite) or aluminium oxide (boehmite) in the ratios of 1 : 10 and 1 : 100.

Increasing amounts of sulphide increased the quantity of phosphate in solution, measured colorimetrically[2] as shown in Figs. 1 and 2.

At all sulphide-levels the amount of phosphate in solution was suppressed when sesquioxides were present, particularly by the finely crystalline aluminium oxide, but less so by the coarser iron oxide. The level of phosphate in solution reached a maximum after several hours and thereafter fell steadily, suggesting refixing of phosphate on the surface of sesquioxide particles.

Sesquioxide would greatly hinder release of phosphate, but in waterlogged siliceous soils, low in sesquioxides, but high in hydrogen sulphide, release of phosphate might be of importance.

I thank Dr. R. J. Swaby for helpful suggestions during this work.

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[1] Bromfield, S. M., *J. Gen. Microbiol.*, **8**, 378 (1953).
[2] Gomori, G., *J. Lab. Clin. Med.*, **27**, 955 (1942).

FORTHCOMING EVENTS

Monday, March 31

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Informal Evening on "Future Radiocommunication Methods for Civil Aircraft". Talk by Mr. W. E. Brunt.

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. H. Toms: "Soil in British Railway Civil Engineering".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. G. Wilkinson: "Transitional Metal–Hydrogen Complex Compounds".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Mr. Thor Heyerdahl: "The Enigma of Easter Island".

Tuesday, April 1

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 10 a.m. and 2.45 p.m.—Dr. G. W. H. Gardner, Mr. A. D. Baxter and Mr. L. H. Bedford: "Rockets and Guided Flight" (Leonardo da Vinci Lectures).

INSTITUTE OF REFRIGERATION (joint meeting with the LOW TEMPERATURE GROUP of the PHYSICAL SOCIETY, at the Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1), at 5.30 p.m.—Dr. G. G. Haselden and Dr. L. Klimek: "An Experimental Study of the Use of Mixed Refrigerants for Obtaining Cooling Over a Temperature Range".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Sir Claude Inglis and Mr. F. J. T. Kestner: "The Long-Term Effect of Training Walls in Estuaries".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m. Discussion on "Economic Aspects of Electrical Engineering".

Tuesday, April 1—Wednesday, April 2

INSTITUTE OF BIOLOGY (in the Beveridge Hall, Senate House, University of London, Malet Street, London, W.C.1), at 10 a.m. daily—Second International Symposium on "Freezing and Drying".

NATIONAL COAL BOARD (at the Mining Research Establishment, Worton Hall, Worton Road, Isleworth, Middlesex)—Conference on "The Mechanical Properties of Non-Metallic Brittle Materials".

Wednesday, April 2

PHYSICAL SOCIETY, COLOUR GROUP (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 9.45 a.m. —Eighteenth Annual General Meeting.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Prof. C. W. Allen: "Solar Radiation" (Symons Memorial Lecture).

INSTITUTE OF PETROLEUM (at 61 New Cavendish Street, London, W.1), at 5.30 p.m.—Dr. A. Klinkenberg (N.V. De Bataafsche Petroleum Mij.): "Electrostatics and Explosion Hazards in the Petroleum Industry".

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Meeting on "Gas Chromatography".

Thursday, April 3

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 17 Belgrave Square, London, S.W.1), at 6.30 p.m.—Annual General Meeting, followed by Mr. W. B. Ballard: "New Protective Coatings for Metals".

Saturday, April 5

BRITISH INTERPLANETARY SOCIETY (in the Tudor Room, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Mr. F. R. F. Taylor: "Problems of Handling Large Missiles".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (male, with sound practical and teaching experience) IN CROP HUSBANDRY—The Principal, Institute of Agriculture and Horticulture, Oaklands, St. Albans, Herts (April 4).

ASSISTANT, Grade B (with a good honours degree and preferably teaching experience), IN CHEMISTRY, to teach general chemistry to G.C.E. Advanced Level and assist with teaching of inorganic chemistry at degree level—The Principal, Brighton Technical College, Brighton (April 5).

LECTURER IN PHYSICAL CHEMISTRY, and an ASSISTANT LECTURER (Grade B) IN CHEMISTRY—The Registrar, College of Technology, Portsmouth (April 5).

SPECTROSCOPIST (with an honours degree and/or the A.R.I.C., and a knowledge of, and a special interest in spectroscopy) IN THE PUBLIC ANALYST'S SECTION of the Public Health Department—The Registrar, The University, Bristol (April 8).

ASSISTANT DIRECTOR OF THE ROYAL BOTANIC GARDENS, Kew—Civil Service Commission, 30 Old Burlington Street, London, W.1, quoting Ref. S.4825/58 (April 10).

LYONS FELLOW (graduate in medicine or science (if the latter preferably with a Ph.D. in one of the medical sciences)) FOR MULTIPLE SCLEROSIS AND ALLIED NERVOUS DISEASES, to take part in a combined programme of research, under the direction of the Professor of Pathology, on the biology of myelin and the experimental pathology of the demyelinating diseases—The Registrar, The University, Leeds 2 (April 14).

SENIOR LECTURER IN MATHEMATICS—The Secretary, Royal College of Science and Technology, Glasgow (April 14).

UNIVERSITY DEMONSTRATOR IN PHYSICAL CHEMISTRY—Dr. F. B. Kipping, University Chemical Laboratory, Lensfield Road, Cambridge (April 16).

SENIOR LECTURER (with high academic qualifications and/or professional qualifications, and some teaching experience) IN CHEMICAL ENGINEERING at Neath Technical College—The Director of Education, County Hall, Cardiff (April 17).

ASSISTANT LECTURER IN PHARMACOLOGY—The Registrar, The University, Manchester (April 19).

BACTERIOLOGIST (with a university honours degree in science or equivalent qualifications together with some research experience and a knowledge of, and experience in, general bacteriology) IN THE DIVISION OF FISHERIES AND OCEANOGRAPHY, Commonwealth Scientific and Industrial Research Organization, Cronulla, near Sydney, New South Wales, Australia, to study the importance of bacteria in building up and decomposing organic matter and in metabolizing the various inorganic compounds present in the sea—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 320/137 (April 19).

GRADUATE (preferably with some postgraduate experience in microscopy and/or biology), for work involving applications of ultraviolet and interference microscopy, etc., in biology—The Secretary, Chester Beatty Research Institute, Fulham Road, London, S.W.3, quoting "EMFR" (April 19).

SENIOR LECTURER (university graduate with industrial and teaching experience, and preferably some experience in development work in a branch of electronics) IN APPLIED PHYSICS—The Principal, Twickenham Technical College, Egerton Road, Twickenham, Middx (April 19).

CHAIR OF PHYSICS—The Registrar, University College of Wales, Aberystwyth (April 30).

CHIEF LABORATORY STEWARD (preferably with university or equivalent experience) IN THE DEPARTMENT OF CHEMISTRY, University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 30).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN CHEMISTRY, PHYSICS and allied subjects, for example, PHARMACOLOGY, ENGINEERING or METALLURGY—The Registrar, The University, Manchester 13 (April 30).

RESEARCH ASSISTANT or JUNIOR FELLOW IN AERONAUTICAL ENGINEERING—The Registrar and Secretary, The University, Bristol (April 30).

RESEARCH FELLOW IN THE DEPARTMENT OF NUCLEAR PHYSICS, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 30).

LECTURER or ASSISTANT (Grade B) (with teaching and research experience) IN GEOLOGY (PALÆONTOLOGY AND STRATIGRAPHY) up to the standard of the B.Sc. (Special) degree of the University of London —The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (May 3).

ASSISTANT (with an appropriate honours degree) IN RESEARCH IN AGRICULTURAL BOTANY, for research on crop plant evolution—The Secretary, School of Agriculture, The University, Downing Street, Cambridge (May 16).

ASSISTANT PROFESSOR (preferably with a Ph.D. in a biological subject and experience in electron microscopy) OF ANATOMY at Dalhousie University, Canada—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Canada, May 31).

CHAIR OF MEDICINE—The Registrar, The University, Manchester 13 (May 31).

ASSISTANT (Grade B) TO TEACH PHYSICS—The Principal, College of Technology, Queen Street South, Huddersfield.

PHYSICAL CHEMIST (with a first- or second-class honours degree in chemistry or equivalent, experience of handling radioactive isotopes, all types of counting equipment, and a knowledge of electronics) at the Chemical Research Laboratory, D.S.I.R., Teddington, to lead a small team engaged in radiometric work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.207/8A.

PHYSICIST or ENGINEER, to co-operate in the design and development of a large liquid hydrogen bubble chamber and associated plant for use in high energy nuclear physics research (Ref. No. 220(a)); and a DRAUGHTSMAN, to work with the above (Ref. No. 220(b))—The Registrar, The University, Liverpool 3, stating the appropriate Ref. No.

POSTDOCTORAL AND PREDOCTORAL RESEARCH ASSOCIATES IN EXPERIMENTAL AND THEORETICAL CHEMICAL PHYSICS in the Molecular Excitation Group—Dr. R. W. Nicholls, Department of Physics, University of Western Ontario, London, Ontario, Canada.

QUALIFIED TECHNICIAN or JUNIOR TECHNICIAN (male or female) IN THE PATHOLOGICAL LABORATORY—The Secretary, Wembley Hospital, Wembley, Middlesex.

RESEARCH ASSISTANT (honours graduate in microbiology or zoology) IN THE VACCINE LYMPH DEPARTMENT, for work on the development of tissue culture methods in the bulk production of virus and related viral techniques—The Secretary, The Lister Institute, Elstree, Hertfordshire.

SCIENTIFIC ASSISTANT (ABSTRACTOR) (with a degree in agriculture or natural science and a knowledge of languages)—The Director, Commonwealth Bureau of Pastures and Field Crops, Hurley, Maidenhead, Berkshire.

SCIENTIFIC ASSISTANT (with a good science degree, a reading knowledge of two European languages (preferably other than French or

German), ability to write good English and preferably a knowledge of soil science and plant physiology), for work in a scientific information service involving abstracting and indexing—The Director, Commonwealth Bureau of Soils, Rothamsted Experimental Station, Harpenden, Herts.

Scientist (preferably with a pass degree or at least H.S.C. (science) or equivalent, and an interest in a wide range of scientific subjects), to assist in the planning and operational control of overseas trials, and to collaborate with authors in the preparation and editing of reports from scientific records obtained during trials, the post involves tours of duty abroad—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1732/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Museum (Natural History). Contribution to the Ornithology of Western South Africa: Results of the British Museum (Natural History) South West Africa Expedition, 1949–50. By J. D. Macdonald. Pp. xi+174+7 plates. 35*s*. The Culicine Mosquitoes of the Indo-malayan Area. Part 2: Genus *Heizmannia* Ludlow. By P. F. Mattingly. Pp. 57. 12*s*. 6*d*. Bulletin of the British Museum (Natural History). Entomology. Vol. 5, No. 9: A Study of the Chironomidae (Diptera) of Africa South of the Sahara. By Paul Freeman. Pp. 321–426+1 plate. 30*s*. Vol. 6, No. 1: New and Little-Known Species of African Trichoptera. By D. E. Kimmins. Pp. 1–37. 10*s*. Vol. 6, No. 2: New Hystrichopsyllid Siphonaptera. By F. G. A. M. Smit. Pp. 39–76. 10*s*. Vol. 6, No. 3: Neue Erotyliden aus dem Britischen Museum 21. Beitrag zur Kenntnis der erotyliden (Col.). Von Kurt Delkeskamp. Pp. 77–90. 5*s*. Vol. 6, No. 4: Lectotypes of Trichoptera from the McLachlan Collection now in the British Museum (Natural History). By D. E. Kimmins. Pp. 91–126. 9*s*. Vol. 6, No. 5: New Species of the Genus *Dicercomyzon* Demoulin (Ephemeroptera, Fam. Tricorythidae). By D. E. Kimmins. Pp. 127–136. 4*s*. Vol. 6, No. 6: Revision of the Neotropical Acanthocinini (Coleoptera: Cerambycidae). 2: The Genus *Lagocheirus*. By Lawrence S. Dillon. Pp. 137–166. 7*s*. 6*d*. Geology. Vol. 3, No. 3: The Oligocene Flora of the Bovey Tracey Lake Basin, Devonshire. By M. E. J. Chandler. Pp. 71–123+plates 11–17. 25*s*. (London: British Museum (Natural History), 1957.) [3112

Ministry of Power: Safety in Mines Research Establishment. Safety in Mines Research 1956: Thirty-fifth Annual Report. Pp. 75+4 plates. (London: H.M. Stationery Office, 1958.) 4*s*. net. [3112

General Register Office. The Registrar General's Quarterly Return for England and Wales of Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates; quarter ended 30th September, 1957. (No. 435, 3rd Qtr. 1957.) Pp. 24. (London: H.M. Stationery Office, 1957.) 1*s*. 6*d*. net. [3112

The British Gelatine and Glue Research Association. Ninth Annual Report for the year October 1956 to September 1957. Pp. 16. (London: British Gelatine and Glue Research Association, 1957.) [3112

Grassland Research Institute. Experiments in Progress No. 9: Annual Report for 1956. Pp. viii+61. (Hurley, near Maidenhead: Grassland Research Institute, 1957.) 5*s*. [3112

Flora of Tropical East Africa. Orobanchaceae. Edited by Dr. W. B. Tyrrill and E. Milne-Redhead. Pp. 7. (London: Crown Agents for Oversea Governments and Administrations, 1957.) 1*s*. 6*d*. [3112

Dental Practitioners' Formulary 1957, for use in the National Health Service. Pp. 49. (London: British Medical Association and The Pharmaceutical Press, 1957.) 3*s*. [3112

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1957, No. 3: Zone Refining. By N. L. Parr. Pp. ii+29+6 plates. (London: Royal Institute of Chemistry, 1957.) 5*s*. net. [3112

Kent Incorporated Society for Promoting Experiments in Horticulture. Abstracts and Index to the Annual Research Reports, 1913–1953, East Malling Research Station. Pp. vi+175. (East Malling: East Malling Research Station, 1957.) 20*s*. [3112

United Kingdom Atomic Energy Authority: Research Group. Report on the Conference on the Utilisation of Heat from Nuclear Reactors, held at Harwell on 18th January, 1957. Pp. 87. (A.E.R.E. CR/R 2257.) (London: H.M. Stationery Office, 1957.) 10*s*. net. [3112

Other Countries

Sveriges Geologiska Undersökning. Ser. Aa, No. 187: Beskrivning till Kartbladet, Vårvik. Av Walter Larsson och Ragnar Sandegren. Pp. 116 med en tavla. 10 kronor med karta. Ser. Aa, No. 199: Beskrivning till Kartbladet Uppsala. Av P. H. Lundegårdh och G. Lundqvist. Pp. 117+1 plate. 10 kronor med karta. (Stockholm: Kungl. Boktryckeriet P. A. Norstedt and Söner, 1956.) [3112

University of California Publications in Botany. Vol. 29, No. 2: Systematic Anatomical Studies on Myrrhidendron and Other Woody Umbellales. By Raefel Lucas Rodriguez. Pp. 145–318+plates 36–47. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1957.) 3.50 dollars. [3112

U.S. Department of Commerce: Weather Bureau. Technical Paper No. 32: Upper-Air Climatology of the United States. Part 1: Averages for Isobaric Surfaces—Height, Temperature, Humidity, and Density. By Benjamin Ratner. Pp. iv+199. (Washington, D.C.: Government Printing Office, 1957.) 1.25 dollars. [3112

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Scientifique, No. 72: Symbiose *Rhizobium*-Légumineuses en Région Equatoriale. Par Charles Bonnier. Pp. 67. 60 francs. Série Technique, No. 52: Essai Théorique de Détermination de la Puissance Utile au Sciage en Fonction des Variations Dimensionnelles. Par R. C. Antoine. Pp. 32. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1957.) [3112

United States Naval Observatory. Circular No. 32: Positions, Areas, and Counts of Sunspots, April, 1957. By Winifred Sawtell Cameron. Pp. 8. (Washington, D.C.: United States Naval Observatory, 1957.) [3112

The Market for Apples and Pears in O.E.E.C. Countries. Pp. 50. (Paris: Organization for Economic Co-operation; London: H.M. Stationery Office, 1957.) 150 French francs; 3*s*.; 0.50 dollars. [3112

Control of Losses in Young Farm Animals. Pp. 196. (Project No. 345.) (Paris: European Productivity Agency of the Organization for European Economic Co-operation; London: H.M. Stationery Office, 1957.) 600 French francs; 12*s*.; 2 dollars. [3112

University of Bombay. Botanical Memoirs, No. 3: Precipitation Effectiveness in Relation to the Vegetation of India, Pakistan and Burma. By Dr. F. R. Bharucha and Dr. G. Y. Shanbhag. Pp. vii+109. (Bombay: The University, 1957.) Rs. 1.50. [3112

New South Wales: Department of Agriculture. Contributions from the New South Wales National Herbarium, Vol. 2, No. 6: A Review of the Family Oleaceae. By L. A. S. Johnson. Pp. 395–418. (Sydney: New South Wales National Herbarium, 1957.) [3112

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 38 (November, 1957): Increased Chances of a Golden Wedding. Continued Progress Against Tuberculosis. Death Tolls from Fires and Explosions. Aspects of the Suicide Problem. Pp. 12. (New York: Metropolitan Life Insurance Company, 1957.) [3112

Bulletin of the Florida State Museum. Biological Sciences. Vol. 2, No. 6: The Biology and Systematics of the Pinfish, *Lagodon Rhomboides* (Linnaeus). By David K. Caldwell. Pp. 77–174. 1.25 dollars. Vol. 2, No. 7: Historical Biogeography of Present-Day Florida. By Wilfred T. Neill. Pp. 175–220. 60 cents. (Gainesville, Fla.: Florida State Museum, 1957.) [3112

Smithsonian Miscellaneous Collections. Vol. 134, No. 12: Permian Brachiopods from Central Oregon. By G. Arthur Cooper. Pp. iv+79+12 plates. (Publication 4302.) Vol. 135, No. 2: Morphology and Taxonomy of the Foraminiferal Genus *Pararotalia* Le Calvez, 1949. By Alfred R. Loeblich, Jr., and Helen Tappan. Pp. ii+24+5 plates. (Publication 4303.) Vol. 135, No. 5: Mineralogical Studies on Guatemalan Jade. By William F. Foshag. Pp. ii+60+4 plates. (Publication 4307.) Vol. 135, No. 6: A Revised Interpretation of the External Reproductive Organs of Male Insects. By R. E. Snodgrass. Pp. iii+60. (Publication 4309.) (Washington, D.C.: Smithsonian Institution, 1957.) [3112

Commonwealth of Australia. Fifth Annual Report of the Australian Atomic Energy Commission for the year ended 30th June, 1957. (Sydney: Government Printer, 1957.) [3112

United States Department of the Interior: Geological Survey. Professional Paper 280–B–D: Geology of Saipan, Mariana Islands. Part 2: Petrology and Soils. Chapter B: Petrology of the Volcanic Rocks. By Robert G. Schmidt. Chapter C: Petrology of the Limestones. By J. Harlan Johnson. Chapter D: Soils. By Ralph J. McCracken. Pp. viii+127–207+plates 2,4, 26–36. Professional Paper 280–E–J: Geology of Saipan, Mariana Islands. Part 3: Paleontology. Chapter E: Calcareous Algae. By J. Harlan Johnson. Chapter F: *Discoaster* and Some Related Microfossils. By M. N. Bramlette. Chapter G: Eocene Radiolaria. By William R. Reidel. Chapter H: Smaller Foraminifera. By Ruth Rodd. Chapter I: Larger Foraminifera. By W. Storrs Cole. Chapter J: Echinoids. By C. Wythe Cooke. Pp. viii+209–360+plates 37–119. (Washington, D.C.: Government Printing Office, 1957.) [3112

Companhia de Diamantes de Angola (DIAMANG), Servicos Culturais. Museu do Dundo. Publicacoes Culturais, No. 32: Subsidios para a Estudo da Biologia na Lunda. Coléoptères Psélaphides de l'Angola. (Deuxième série). Par Dr. Rene Jeannel. Pp. 112. (Lisboa: Companhia de Diamantes de Angola, 1957.) [3112

Transactions of the American Philosophical Society. New Series, Vol. 47, Part 5: Maistre Nicole Oresme: Le Livre de Yconomique d'Aristote. (Critical Edition of the French Text from the Avranches Manuscript with the Original Latin Version, Introduction and English Translation.) By Prof. Albert Douglas Menut. Pp. ii+783–854. 2 dollars. New Series, Vol. 47, Part 6: Nikolas Mesarites: Description of the Church of the Holy Apostles at Constantinople. Greek Text, Edited with Translation, Commentary, and Introduction, by Glanville Downey. Pp. ii+855–924. 2 dollars. (Philadelphia: American Philosophical Society, 1957.) [3112

Architectural Science, No. 2: Proceedings of the Symposium on Structure and Architecture. Edited by Prof. Henry J. Cowan. Pp. xii+95–200. (Sydney: Sydney University Extension Board, 1957. Copies obtainable from Academic Press, Pty., Ltd., Box 4251, G.P.O., Sydney.) 21*s*. [131

Canada. National Research Council: Division of Building Research. Research Paper No. 38: Some Results of the Snow Survey of Canada. By L. W. Gold and G. P. Williams. Pp. ii+8+7 figures. (NRC 4389.) 25 cents. Research Paper No. 40: An Analysis of Snow Cover Characteristics at Aklavik and Resolute, Northwest Territories. By G. P. Williams. Pp. ii+5+7 figures. (NRC 4473.) 25 cents. (Ottawa: National Research Council of Canada, 1957.) [131

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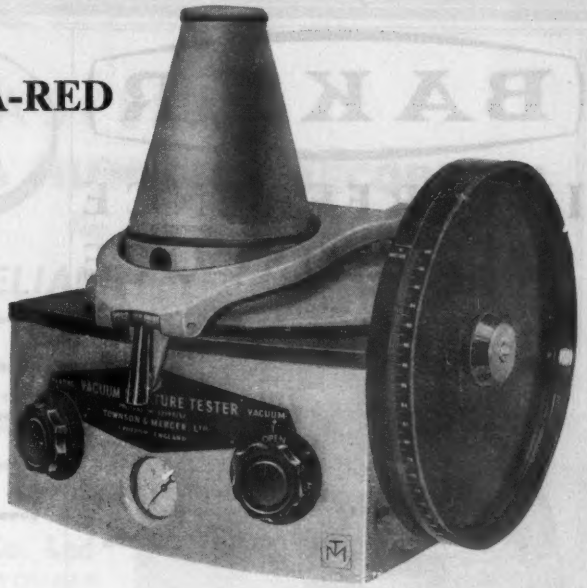

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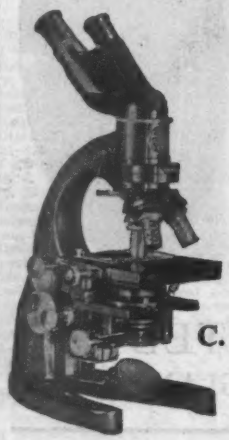

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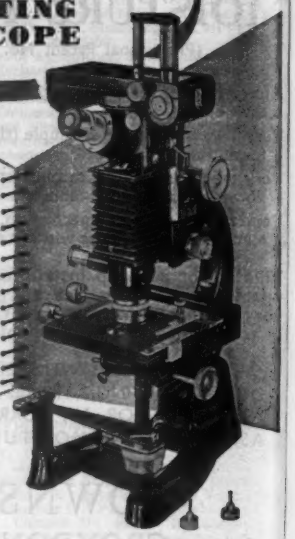

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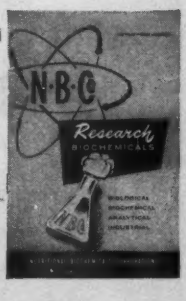

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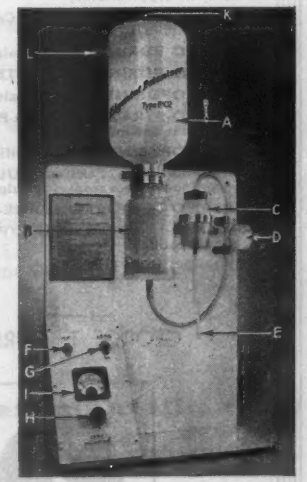

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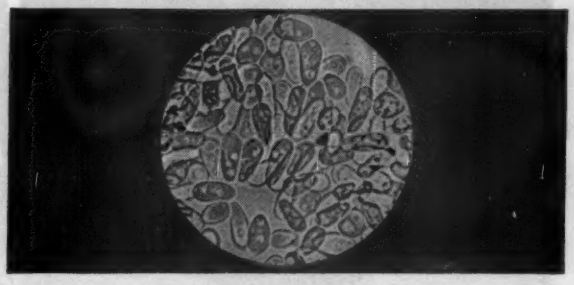

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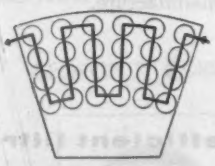

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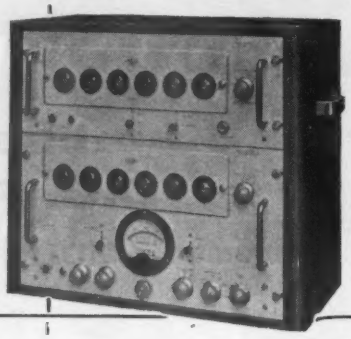

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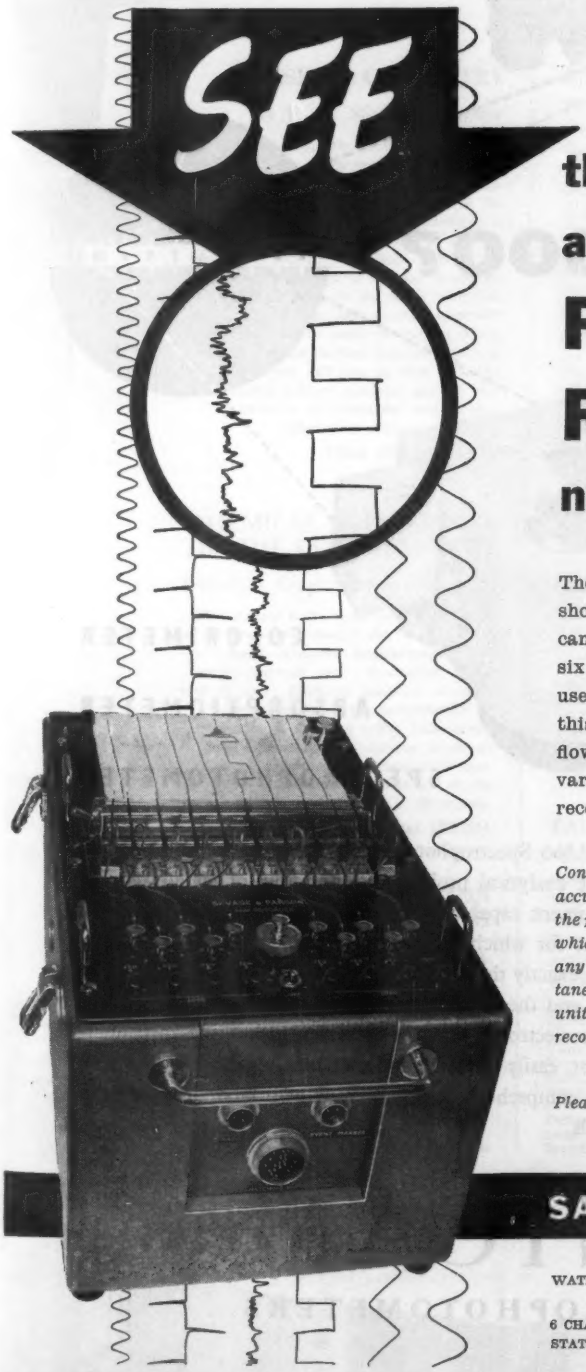

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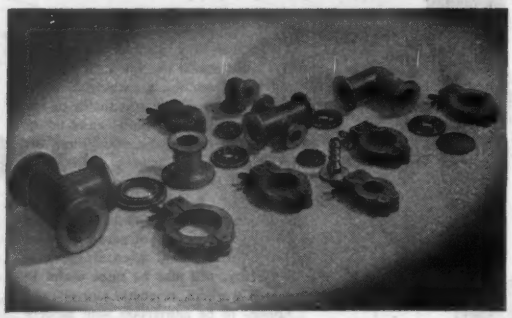

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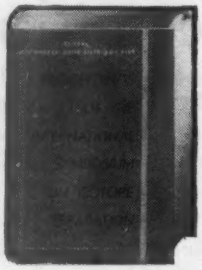

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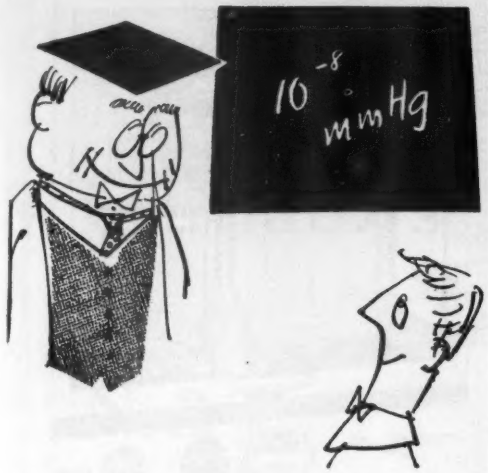

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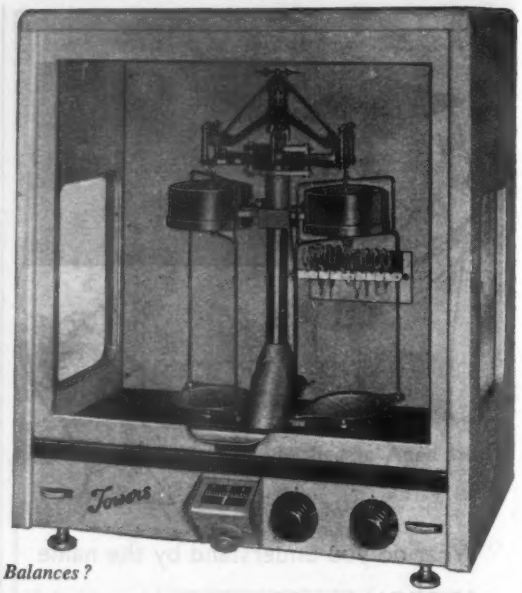

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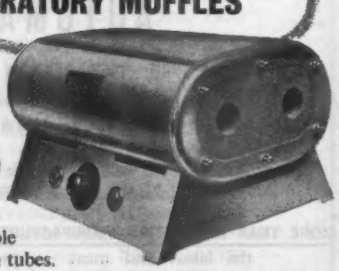

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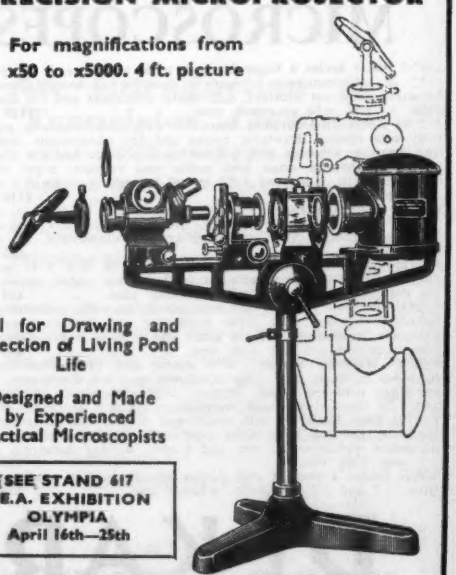

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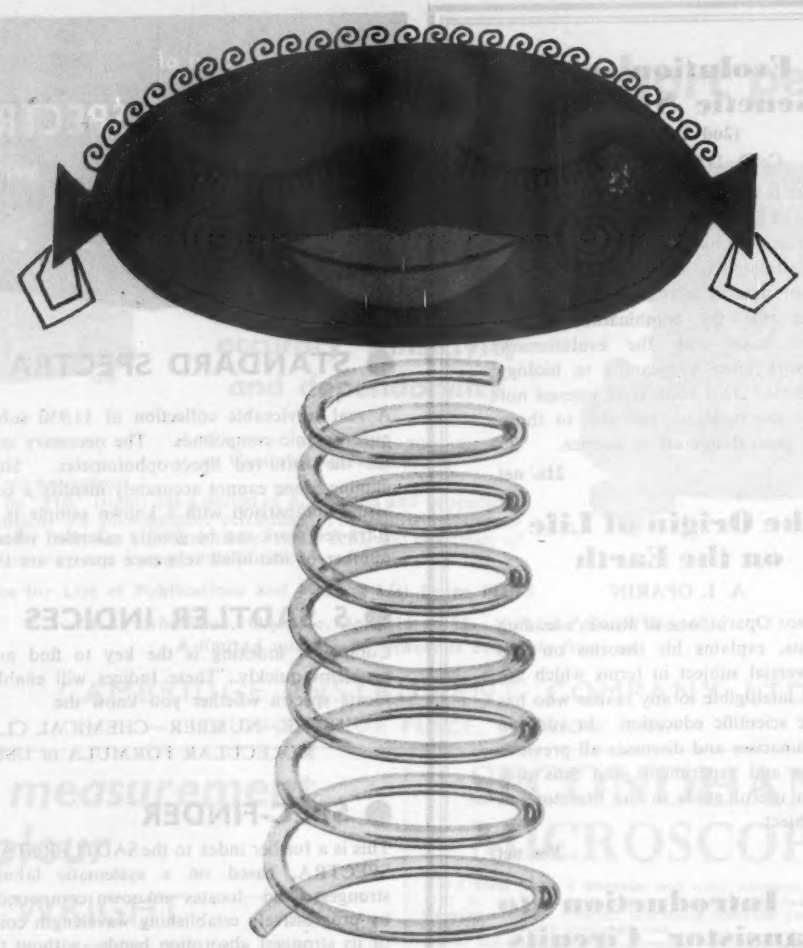

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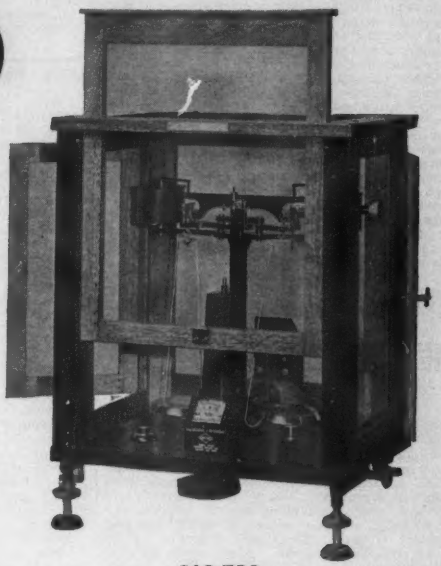

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LECTURES AND COURSES

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF CIVIL ENGINEERING
GRADUATE COURSE IN HIGHWAY ENGINEERING
GRADUATE COURSE IN FOUNDATION ENGINEERING

The above mentioned postgraduate courses are provided annually in the Graduate School of Highway Engineering and the Graduate School of Foundation Engineering and are intended primarily for honours graduates, preferably with at least two years' experience in a branch of Civil Engineering, Highway work or allied subjects. Applicants with other qualifications may also be considered for admission. On successful completion of the courses, graduate students become eligible for the degree of M.Sc. by examination and report, and non-graduates for the Diploma of Graduate Studies, both subject to the general regulations of the University. Both courses include thorough training in the latest soil mechanics methods, theoretical and practical. Design and laboratory projects are arranged to suit individual students. Courses for the Session 1958-9 will commence on October 6, 1958, and will be of twelve months duration, of which nine months will be spent at the University. The inclusive course fee is £81.

A limited number of maintenance awards in connection with these courses is available for British students. Particulars of these awards, together with a syllabus of the courses and application forms, may be obtained from the Registrar, The University, Edgbaston, Birmingham, 15. Candidates applying for admission in October, 1958, should make application as early as possible but in any case not later than August 31. Applications from candidates who are also seeking financial assistance, should be received not later than May 31. Inquiries concerning these courses are also invited from employers on behalf of their staff.

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF CHEMICAL ENGINEERING
COURSE FOR M.SC.(CHEM.ENG.) IN BIOLOGICAL ENGINEERING

A postgraduate course leading to the degree of M.Sc.(Chem.Eng.) in Biological Engineering will commence in October, 1958. The course will extend over one year for students holding a good honours degree or postgraduate diploma in chemical engineering. Students holding honours degrees in other subjects, such as chemistry, engineering physics, biology and biochemistry will be considered for admission to a two-year course, the first year being devoted to general study of the principles of chemical engineering. The M.Sc. course will include the study of microbiology and biochemistry, the design and operation of fermentation equipment, and chemical engineering problems in the food industries and in the biological disposal of effluents. The practical work, including operation of pilot-plant equipment, will be arranged to provide training in research methods. Facilities for research leading to the degrees of M.Sc. or Ph.D. are available.

Further information and forms of application for admission may be obtained by writing to The Registrar, the University, Edgbaston, Birmingham, 15.

OFFICIAL APPOINTMENTS

FEDERATION OF NIGERIA

FISHERIES RESEARCH OFFICER

to undertake research into pond culture of local species of fish and into the chemistry and plankton populations of fish ponds to ensure the most profitable use of available nutrients, foodstuffs and fertilizers. Candidates must possess an honours degree in biology with emphasis on zoology; appropriate knowledge of chemistry and of statistical methods; ability to read French and possibly German. Experience of similar or related work an advantage. Appointment on contract terms in scale £870 to £1,824 with a gratuity of £25 to £37 10s. for each period of three months satisfactory service. Continuance of contributions to an existing superannuation scheme in the United Kingdom, e.g., F.S.S.U. can be considered. Outfit allowance £60. Free passages for officer, wife and children on appointment and leave not exceeding a total of four adult return passages. Government quarters at moderate rental. Taxation at local rates.

Apply, giving brief particulars, to Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.65/14/01.

CHESTER BEATTY RESEARCH INSTITUTE

INSTITUTE OF CANCER RESEARCH
ROYAL CANCER HOSPITAL

Graduate required for work involving applications of ultra-violet and interference microscopy, etc., in biology. Person with some postgraduate experience in microscopy and/or biology preferred. The post is permanent and superannuable, and salary will be on a scale in accordance with age and qualifications.

Applications, giving names of two referees and marked "EMFR," should be sent to the Secretary, Chester Beatty Research Institute, Fulham Road, London, S.W.3, by April 19, 1958.

UNIVERSITY OF WESTERN ONTARIO

DEPARTMENT OF PHYSICS
RESEARCH ASSOCIATESHIPS IN EXPERIMENTAL AND THEORETICAL PHYSICS

Applications are invited for postdoctoral and predoctoral Research Associateships in experimental and theoretical chemical physics tenable in The Molecular Excitation Group from August, 1958. The research interests of the group cover a wide range of excitation problems related to combustion, radiation chemistry, astrophysics, and atmospheric physics.

Further information may be obtained by writing by air mail to Dr. R. W. Nicholls, Department of Physics, University of Western Ontario, London, Ontario, Canada.

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)
MILE END ROAD, E.1

Applications are invited for a LECTURESHIP IN ELECTRICAL ENGINEERING. Experience in electronics and instrumentation for automatic control is desirable. Salary scale £900 by £50 to £1,350 (efficiency bar): £1,425 by £75 to £1,650 plus London allowance of £60. Tenable from October 1, initial salary according to qualifications and experience, with F.S.S.U. participation and family allowance of £50 per child.

Application forms (obtainable from the Registrar) to be returned by April 30.

METABOLIC DISTURBANCES IN SURGERY

MEDICAL RESEARCH COUNCIL UNIT
THE GENERAL INFIRMARY, LEEDS, 1

Applications are invited for a Biochemist, preferably with Ph.D., to work on the metabolism of magnesium. The successful applicant will be required to work in collaboration with the Directors of the Unit and in conjunction with a physicist who is developing spectrographic methods for estimating magnesium. The appointment is a new one and is now vacant. It is subject to the regulations laid down by the Medical Research Council.

Candidates should apply to the Honorary Director of the Unit, giving the names of three referees.

ROYAL NAVAL SCIENTIFIC SERVICE requires Physicists, Electronic Engineers, and Mathematicians for 25 Senior Scientific and Scientific Officer posts at establishments in London area, Baldock, Harwell, Haslemere, Poole, Greenock, and Rosyth. Also required: Mechanical Engineer for work on heat transfer problems at Harwell. Mechanical Engineer for work on fuel and lubricating oil problems in London area. Mechanical Engineer for work on gas turbine and problems in London area. Chemical Engineers for London area and Poole. Metallurgists for Rosyth and Poole. Chemists (physical and inorganic) for Poole and Baldock. Candidates must normally be natural born British subjects of natural born British parents, with at least first- or second-class honours degrees or equivalent high professional attainments. Senior Scientific Officers must have had at least three years' postgraduate experience and be 26 years of age. Salaries (men): Senior Scientific Officer, £1,190 to £1,410 Scientific Officer, £635 to £1,110 (London)—somewhat lower in provinces. Appointments are unestablished (with F.S.S.U. benefits), but opportunities may occur for those under 32 to compete for established posts.—Forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.98/8A.

McGILL UNIVERSITY

POSTGRADUATE ASSISTANTSHIPS IN CHEMISTRY

Applications are invited for Demonstratorships and Research Assistantships from persons qualified to pursue graduate studies leading to the M.Sc. and Ph.D. degrees in chemistry. Stipends during the academic session (October to May inclusive) are commensurate with the duties undertaken, and a supplementary grant of $800 is paid during the summer (June to September inclusive), while the applicant continues in research for the chosen degree. Research opportunities are present in:—Organic Chemistry: reaction mechanisms, structure of heterocyclic compounds and of steroids, wood chemistry including cellulose, lignin, bark and related substances, interpretation of infra-red and ultra-violet absorption spectra. Inorganic and Radiochemistry: structure and separation of rare earth, germanium, and silicon compounds, nuclear fission and spallation, absolute disintegration rate determinations, new radioactive species, crystal growth of metals, preparation and study of single crystals. Physical and Colloid Chemistry: corrosion and electrodeposition of metals, diffusion in metal alloys, electrochemistry in non-aqueous solvents, studies on active nitrogen, gas phase thermal reactions, mass spectrometry of transient species, studies with the surface film balance, adsorption, ultracentrifugal and electrophoretic studies of colloids, hydrodynamics of fibres including cellulose and wood fibres, physical chemistry of lignin and of proteins, including antibody-antigen reactions.

For further information please write to Prof. C. A. Winkler, Chairman, Department of Chemistry, McGill University, Montreal, Quebec, Canada.

RESEARCH COUNCIL OF ALBERTA

POSTDOCTORATE FELLOWSHIPS IN CHEMISTRY

Applications are invited for postdoctorate fellowships for fundamental research in the following fields: "Electron Paramagnetic Resonance" with emphasis on free radicals in solution including the oxidative polymerization of phenols; "Sorption of Gases" and the physical properties of the sorbed phase; "Kinetics of Gas Phase Reactions" and kinetic isotope effects. The latest in modern instrumentation will be available for these studies. Applicants should have, or expect to have, a Ph.D. or equivalent degree before taking up the award. The annual stipend, $3,700, single, or $4,500, married, is tax free; an allowance for travel will also be made. Awards are tenable for one year and may be renewed for one additional year.

Inquiries and a brief summary of interests and experience should be addressed to the Secretary, Research Council of Alberta, Edmonton, Alberta.

ASSISTANT DIRECTOR

required by the
BREWING INDUSTRY RESEARCH FOUNDATION
NUTFIELD, SURREY

Preference will be given to senior candidates having high academic qualifications in the general fields of biochemistry and microbiology, together with experience in the administration of a research establishment. The post will carry a salary commensurate with its seniority and responsibility and is superannuable under F.S.S.U.

Applications, giving full relevant details of age, qualifications and experience, should reach the Secretary, The Institute of Brewing, 33 Clarges Street, London, W.1, not later than April 7, 1958.

UNIVERSITY OF LONDON COMPUTER Unit. Applications are invited for the following posts on the staff of the Unit, which is equipped with a Mercury computer: Lecturer: salary scale £900 by £50 to £1,350 plus £60 London allowance; Assistant Lecturer: salary scale £700 by £50 to £850 plus £60 London allowance, for appointment with effect from August 1, 1958, or as soon thereafter as possible. Research Assistant, with experience in numerical analysis and programming, to help with preparation and running of problems on computer; salary within range £500 to £850 plus £60 London allowance, with possibility of promotion to scale £900 by £50 to £1,200 plus £60 London allowance. Appointment to take effect as soon as possible. Children's allowances and membership of F.S.S.U.—Applications (five copies), with names and addresses of two referees, to be sent before April 21, 1958, to the Director, University of London Computer Unit, c/o Department of Physics, University College, Gower Street, W.C.1.

CITY AND COUNTY OF NEWCASTLE UPON TYNE EDUCATION COMMITTEE

RUTHERFORD COLLEGE OF TECHNOLOGY

(Selected for development into a College of Advanced Technology)

Applications are invited from suitably qualified candidates for the following vacancies, duties to commence as soon as possible:

(a) Department of Mathematics and Physics: Lecturer in Physics for Higher National Diploma, Dip.Tech., and degree courses. Candidates should hold a good honours degree and have teaching and, preferably, industrial and/or research experience.

(b) Department of Chemistry and Metallurgy: Lecturer in Physical Chemistry to teach up to Final B.Sc. and Grad.R.I.C. (Part II) level. Candidates should hold an honours degree in chemistry and have had appropriate teaching and/or industrial experience. The ability to initiate and direct research would be an advantage.

Salary in accordance with the Burnham Technical Report, 1956: Lecturer, £1,200 by £30 to £1,350.

Application forms (returnable within 14 days) and further particulars may be obtained from the Principal, Rutherford College of Technology, Bath Lane, Newcastle upon Tyne, 1.

H. V. LIGHTFOOT,
Clerk to the Governors.

COLLEGE OF AERONAUTICS

ENGLISH ELECTRIC RESEARCH FELLOWSHIP IN AERONAUTICS

Applications are invited for a Research Fellowship which has been established at the College by The English Electric Co. Ltd. The Fellowship is intended to provide opportunity for post-graduate research into the problems of vibration or stability and control of aircraft, and is tenable for one year beginning on or about October 1, 1958. The value of the Fellowship is £750.

Applications, giving full particulars of education and experience and quoting the names of three referees, are required by May 1, 1958, and should be addressed to The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks.

STUDLEY COLLEGE

WARWICKSHIRE

AGRICULTURAL COLLEGE FOR WOMEN

(Diploma Courses in Horticulture and Dairy Farming)

Lecturer in Chemistry (woman) required September. Salary, according to experience and qualifications, will be on either the Senior Assistant (£840 by £24 to £960) or the Assistant grade for Lecturers in Farm Institutes plus appropriate allowances. F.S.S.U. Residence £140.

Applications by April 11, 1958.

ACADIA UNIVERSITY

CANADA

Applications are invited for the positions of Lecturer in Mathematics and Lecturer in Philosophy commencing September, 1958. All work is at the undergraduate level. Salary range £1,000 to £1,300 per annum, depending on the qualifications and experience of the successful applicant. Closing date for applications, April 15, 1958.

Details from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

UNIVERSITY OF ABERDEEN

Applications are invited for I.C.I. Research Fellowships in Biochemistry, Chemistry, Engineering, Pharmacology, or Physics. Appointment from October 1, 1958. Salary in range £700 to £1,000, with placing according to qualifications and experience. F.S.S.U. and child allowance.

Conditions of appointment and forms of application, should be obtained from the Secretary, the University, Aberdeen, with whom applications (ten copies), should be lodged by April 18, 1958.

WESTMINSTER SCHOOL REQUIRE IN September: 1. A Senior Physics Master to take charge of the department and to organize the new Laboratories which are now under construction. Ability to teach to scholarship standard essential. 2. A Biology Master to assist with the biology teaching throughout the School, if possible to scholarship standard, and also to teach some elementary chemistry or physics. New Chemistry and Biology Laboratories are also now under construction. Salaries by arrangement in accordance with qualifications and experience.—Candidates should apply to The Head Master, Westminster School, Dean's Yard, S.W.1.

LECTURER IN MECHANICAL ENGINEERING

The Governing Body invite applications for a Lectureship in Mechanical Engineering in the College of Science and Technology, with the title status of Lecturer in the University of Manchester. The Department covers a very wide range of aspects of mechanical and production engineering and all members of staff are expected to undertake, assist in, or supervise research. Salary: According to qualifications, on scale £900 by £50 to £1,350 by £75 to £1,650. Superannuation under F.S.S.U. Family allowances.

Conditions of appointment and form of application may be obtained from the Registrar, The Manchester College of Science and Technology, Manchester, 1. The last day for the receipt of applications is April 30, 1958.

UNIVERSITY COLLEGE OF NORTH WALES

BANGOR

Applications are invited for the post of Assistant Lecturer in Zoology. Candidates should have a special interest in some aspect of vertebrate zoology. The salary scale is £700 by £50 to £850 per annum, and in addition, there are F.S.S.U. benefits and family allowances. The appointment will date from October 1, 1958.

Two copies of the application should reach the undersigned, from whom further particulars may be obtained, not later than April 30, 1958.

KENNETH LAWRENCE,
Secretary and Registrar.

WILMOT BREEDEN FELLOWSHIP

Applications are invited for a Fellowship to be held in association with the College of Technology, Birmingham. The value of the Fellowship, which is for a two-year term, is £1,000 per annum.

A candidate for the Fellowship should normally have had two or three years' research or industrial experience. He must be acceptable to the College of Technology, Birmingham, as a postgraduate student, and should have an honours degree at a university in the British Commonwealth or an equivalent qualification.

The Wilmot Breeden Fellow will engage in an enterprise of such a character as to require the facilities both of the College and of the Company, and his time will be divided between the two. The activities with which the Company is especially concerned include mechanisms, electrochemistry, metal finishing, metallurgy, metal formation, hydraulics, electronics.

Full details may be obtained on application to the Secretary, Wilmot Breeden Limited, Amington Road, Birmingham, 25.

Final applications must be received by the Secretary before May 1, 1958.

UNIVERSITY OF CAMBRIDGE

SCHOOL OF AGRICULTURE

Applications are invited for the post of Assistant in Research in Agricultural Botany for research on crop plant evolution. Qualifications should include an appropriate honours degree. Salary: £650 by £25 to £850.

Apply, in writing, to the Secretary, School of Agriculture, Downing Street, Cambridge, giving names and addresses of two referees. Closing date for applications is May 16, 1958.

UNIVERSITY OF GLASGOW VETERINARY SCHOOL

A Bacteriologist is required for a research group in certain disease investigations in domestic animals. The project is supported by the Agricultural Research Council. Salary, £900 per annum.

Applications (three copies), should be lodged not later than April 5, 1958, with the Secretary of the University Court, The University, Glasgow, W.2.

ROBT. T. HUTCHESON,
Secretary of University Court.

THE DEPARTMENT OF ZOOLOGY IN THE College of Arts and Science, Baghdad, Iraq, is in need of a Bacteriologist for teaching and research. A Ph.D. in bacteriology is essential, a preference is given to some background in human pathology and teaching experience. Salary according to background of applicant.

DERBY AND DISTRICT COLLEGE OF TECHNOLOGY

Principal: T. Heap, Ph.D., M.Sc., F.R.I.C., A.M.I.I.A.

Applications are invited for the post of full-time Lecturer in Botany, duties to commence on May 1, 1958, or as soon thereafter as possible. The person appointed will be responsible for the teaching and organizing of the subject to degree level. Applicants should have teaching experience and possess an honours degree in botany with subsidiary qualifications in zoology. Salary in accordance with the Burnham Further Education Scale for Lecturers: men, £1,200 by £30 to £1,350; women, £960 by £24 to £1,080. The scale for women is subject to increases under the "equal pay" provisions.

Application forms and details of the post can be obtained from the Principal, Derby and District College of Technology, Normanton Road, Derby, by whom completed applications should be received within two weeks of the appearance of this advertisement.

C. MIDDLETON,
Secretary to the Joint Committee.
Education Office,
Becket Street, Derby.

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

Applications are invited for the post of Senior Lecturer in Chemistry. Duties commence on May 1, 1958, or as soon as possible thereafter. Candidates should possess a good honours degree or higher degree in chemistry and have experience in industry, teaching and/or research. F.R.I.C. is desirable. Salary £1,350 by £50 to £1,550 per annum with additions for industrial or other relevant experience.

Further particulars and application form will be sent by the undersigned. Last date for receipt of applications: Friday, April 11, 1958.

E. C. Smith,
Principal.

METALLURGICAL PHYSICIST REQUIRED by the Atomic Weapons Research Establishment, Aldermaston, Berks, to carry out research and development work on the electro deposition of metals. First- or second-class honours degree in physics or metallurgy or equivalent qualification required. Keenness and aptitude for applied research work is essential, and experience in metallic coatings or related subjects desirable. Salary: Senior Scientific Officer, £1,215 to £1,425 per annum; Scientific Officer, £645 to £1,120 per annum. Contributory superannuation scheme. A house or assistance towards legal expenses on house purchase will be available for married officers living beyond daily travelling distance.—Postcards for application forms to the Senior Recruitment Officer at above address. Please quote ref. C/1428/34.

COMMONWEALTH AGRICULTURAL Bureaux. Scientific Assistant (Abstractor) required for Bureau post at Princes Risborough, near Aylesbury, Bucks. Graduate essential, under 40 years of age, with a good reading knowledge of two to three languages, especially German and Slav. Candidates must be competent to deal with literature in timber physics and mechanics. Some knowledge of biology an advantage. Salary £595 to £1,460. Starting salary according to age, qualifications and experience. For candidates under 32 years old, increments up to two years granted for completed years of compulsory National Service, and two further increments in suitable cases after two years' service. Provision for superannuation.—Apply, with full particulars and names of three referees (work and character), by April 20, to Commonwealth Forestry Bureau, South Parks Road, Oxford.

DEPARTMENT OF SCIENTIFIC AND INdustrial Research: Geologists. At least seven pensionable posts in Geological Survey and Museum for men or women aged 21 and under 30 (31 for permanent members of Experimental Officer Class) on July 1, 1958, extension for regular Forces services or Overseas Civil Service. Candidates must normally have (or obtain in 1958) first- or second-class honours degree in geology. Some posts require special qualifications in mineralogy and petrology or good knowledge of physics or chemistry and some involve short-term overseas field investigations on radioactive mineral deposits. Men's salary £635 to £1,110 (London). Provision for starting pay above minimum. Five-day week. Promotion prospects.—Write Civil Service Commission, 30 Old Burlington Street, London, W.1, for application form, quoting S.168/58. Closing date April 15, 1958.

SCIENTIFIC RESEARCH COMMITTEE

JAMAICA

EXECUTIVE SECRETARY

The Government of Jamaica has established a Scientific Research Committee, an interim body which will later be formed into a permanent organization. It will deal with Industrial, Agricultural, Marketing, and Allied Research. Applications are invited for the post of Executive Secretary for a period of three years in the first instance. Applicants should hold a good honours degree in science or equivalent professional qualification and have administrative and research experience. Acquaintance with development programmes, operations and methods of research organizations would be an advantage.

Applicants should state educational qualifications, age, experience, and salary expected. Detailed applications (six copies), naming three referees, should be addressed to The Chairman, Scientific Research Committee, 4 Winchester Road, Kingston, 10, Jamaica, W.I. from whom further particulars may be obtained, and should be received not later than May 31, 1958.

UNIVERSITY OF BIRMINGHAM

Applications are invited for a Lectureship in Metallurgy. Candidates should have a suitable degree and industrial or research experience. The work involves lectures to final-year and postgraduate students, and good opportunities exist for research. Salary within range £900 to £1,650 per annum with F.S.S.U. and family allowances.

Applications (two copies), with the names of three referees, should be sent to the Deputy Registrar, The University, Birmingham, 15, from whom further particulars may be obtained.

NUTRITIONAL RESEARCH UNIT

HUNTINGDON

Applications are invited for two posts for graduate workers to assist with a programme of research relating to human and animal nutrition and to toxicology. A veterinary or agricultural qualification would be an advantage, but is not essential. Previous experience of the use of animals for research desirable. Salary according to age, qualifications and experience.

Applications should be submitted to the Secretary, Nutritional Research Unit, Huntingdon, not later than April 15, 1958.

UNIVERSITY COLLEGE OF WALES

ABERYSTWYTH

DEPARTMENT OF PHYSICS

The College invites applications for the Chair of Physics at a commencing salary of £2,300 per annum.

Further particulars may be obtained from the undersigned, to whom eight copies of applications, together with the names of three referees, should be sent by April 30, 1958.

T. MAELGWYN DAVIES,
Registrar.

ANIMAL HEALTH TRUST

WELLCOME VETERINARY RESEARCH FELLOWSHIPS

Applications are invited for the appointment of a Wellcome Fellow, for whole-time research in connection with veterinary science or medicine, from any person who on October 1, 1958, is under 36 years of age and holds the Membership Diploma of the Royal College of Veterinary Surgeons or a degree in any faculty relevant to veterinary science or medicine in any university in the British Commonwealth and Empire. Applicants are expected to have done some postgraduate work and to provide evidence that they have been able to make arrangements for the satisfactory conduct of the proposed research. A Fellowship may be awarded at an annual value of £850 rising by annual increments of £50. The Fellowship is subject to income tax and carries benefits under the F.S.S.U.; it is tenable for one year in the first instance and by annual reappointment for a further period of two years at the discretion of the Advisory Committee. Election will be made in June, to take effect as from October 1, 1958. Closing date for receipt of applications is Monday, April 28, 1958.

Forms of application are obtainable from The Scientific Director, The Animal Health Trust, 14 Ashley Place, Westminster, London, S.W.1.

COMPUTER REQUIRED FOR MATHEmatics Department of University College London (Gower Street, W.C.1). Woman graduate preferred. Salary £425 to £600.—Applications to Assistant Secretary.

ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW

(Affiliated to the University of Glasgow)

Applications are invited for a

NEW SENIOR LECTURESHIP

in

MATHEMATICS

The salary scale is £1,700 by £75 to £2,000 with superannuation (F.S.S.U.) and children's allowances.

Forms of application may be obtained from the Secretary to whom they should be returned before April 14.

SENIOR PHYSICIST OR ENGINEER

The British Iron and Steel Research Association require a graduate with research experience to guide work in their Sheffield Laboratories, leading to new developments in the rolling of metals. The post offers unusual opportunities to a man with creative interests in metals technology, plant design, or automation, by way of large-scale laboratory facilities and industry-wide contacts. Starting salary up to £1,350 per annum, according to age, qualifications and experience. Post is superannuated under the F.S.S.U.

Written applications only, quoting "M.W.5," to Personnel Officer, 11 Park Lane, London, W.1.

PHYSICIST

required at the

ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL

to develop heavy particle detectors and undertake fundamental research as member of a team studying charged particle reactions using a 50 MeV. proton linear accelerator.

Salary: £645 to £1,215 (Scientific *or* Experimental Officer) depending upon age, qualifications and experience.

Send postcard to the Recruitment Officer (1047Y/34), A.E.R.E., Didcot, Berks, for an application form and details.

UNIVERSITY OF MANCHESTER

There is a vacancy in the Department of Physics for an Electrical or Mechanical Engineer to form part of a research team developing a linear accelerator for nuclear physics research. The work will involve design of new apparatus and the supervision of manufacture of large scale equipment. Salary in accordance with qualifications.

Applications should be sent to Professor S. Devons, The University, Oxford Road, Manchester, 13.

UNIVERSITY OF CAMBRIDGE

Applications are invited for a University Demonstratorship in Physical Chemistry to hold office from October 1, 1958. Applications will close on April 16, 1958.

Details of duties, salary, etc., may be obtained from Dr. F. B. Kipping, University Chemical Laboratory, Lensfield Road, Cambridge.

UNIVERSITY OF ABERDEEN

Applications are invited for the following posts: Geology: Lecturer. Mathematics: Lecturer. Natural Philosophy: Experimental Physics, Senior Lecturer or Lecturer, and Assistant; Theoretical Physics, Lecturer and Assistant. Salary scales: Senior Lecturer, £1,650 to £2,150; Lecturers, £900 to £1,650; Assistants, £700 to £850. Placing according to qualifications and experience. F.S.S.U. and child allowance.

Particulars from the Secretary, the University, Aberdeen, with whom applications should be lodged by April 18, 1958, as follows: Senior Lecturer and Lecturers, eight copies; Assistants, two copies.

NORTHERN POLYTECHNIC

HOLLOWAY, LONDON, N.7

The Governing Body invite immediate applications for appointment as SENIOR LECTURER IN MATHEMATICS to teach to degree standard. Active interest in research in some branch of applied mathematics essential. Salary scale: men, £1,350 by £50 to £1,550; women, £1,234 by equal pay increments to £1,550, plus London allowance.

Apply for form of application and further particulars to the Clerk to the Governors.

AUSTRALIAN NATIONAL UNIVERSITY

CANBERRA

RESEARCH SCHOOL OF PHYSICAL SCIENCES

Applications are invited for the position of Fellow in the Department of Geophysics. The Fellow will be required to assist in the Department's programme of work on rock magnetism and should have experience in physics, geology or petrology likely to be relevant to this work. The salary and range of a Fellow are determined within the limits £A.1,750 to £A.2,450 and the appointment will be made for an initial period of five years; thereafter it may be made permanent. Superannuation on the F.S.S.U. pattern will be provided and reasonable removal expenses will be paid.

Further details are available from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close, in Australia and London, on April 30, 1958.

UNIVERSITY OF ADELAIDE

AUSTRALIA

Applications are invited for appointment as Reader in Biochemistry. The teaching duties of the Reader will be almost entirely concerned with the honours year and the supervision of postgraduate research students. Salary scale: £A.2,560 by £A.60 to £A.2,800; with superannuation on the F.S.S.U. basis. Copies of the general conditions of appointment of lecturers in the University may be had on application to the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1, or to the Registrar. The Calendar of the University may be seen in the Library of any University which is a member of the A.U.B.C.; and any further information desired will be supplied on request.

Applications, in duplicate and giving the information listed in the general conditions of appointment, should reach the Registrar, University of Adelaide, Adelaide, South Australia, not later than April 30, 1958.

DALHOUSIE UNIVERSITY

CANADA

Applications are invited for appointment as Assistant Professor of Anatomy. The person appointed will be required to teach Histology and Embryology, and to develop teaching and research in embryology. He should preferably hold a Ph.D. in a biological subject, and experience in electron microscopy would be an advantage. Appointment will be for two years in the first instance. Initial salary $5,500 per annum.

Further details from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close in Canada and in London on May 31, 1958.

WEMBLEY HOSPITAL

(CHARING CROSS GROUP)

(135 beds)

Senior Pathological Technician (male or female) required in April. I.M.L.T. essential. Good working conditions.

Apply immediately, with full details, to Secretary, Wembley Hospital, Wembley, Middlesex.

BEDFORD COLLEGE (UNIVERSITY OF London), Regent's Park, N.W.1. Applications are invited for the post of Technician in the Department of Geography, vacant immediately; open to men and women. Salary range: £420 to £570 per annum, plus London weighting in accordance with University of London scales; initial salary according to qualifications and experience. Experience in a similar University Department essential.—Apply immediately to the Secretary.

COMMONWEALTH AGRICULTURAL Bureaux. Applications are invited for the post of Scientific Assistant at the Commonwealth Bureau of Plant Breeding and Genetics, Cambridge. Work includes the abstracting and reviewing of biological literature. Applicants should possess an honours degree in biological sciences, some knowledge of foreign languages and the ability to write correct English. Salary £595 to £1,460. Starting salary according to age, qualifications and experience. Increments up to two years granted for completed years of compulsory National Service and two further increments after two years' satisfactory service for applicants under age 32. Provision for superannuation.—Applications, with full particulars and names of referees (work and character), should be submitted by May 16, 1958, to the Director of the Bureau, School of Agriculture, Cambridge.

NEW SOUTH WALES
AUSTRALIA
CIVIL ENGINEERS FOR DEPARTMENT OF MAIN ROADS

Applications are invited from graduates (or undergraduates in their final year) in civil engineering of a recognized British or Irish University for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges. On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road construction and maintenance either in the Metropolitan Area or the country. Commencing salary according to qualifications and experience, will be within the range £A.1,137 to £A.1,343 per annum, with annual progression, subject to technical competence, to £A.1,869 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months. Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to satisfactory medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent General for New South Wales, 56 Strand, London, W.C.2.

QUEEN ELIZABETH COLLEGE
(UNIVERSITY OF LONDON)
CAMPDEN HILL ROAD, W.8

Applications are invited for the post of Lecturer in Physiology, vacant in October, 1958. Preference given to candidates with teaching experience and special interest in biochemistry. Salary scale: £900 by £50 to £1,350; £1,425 by £75 to £1,650, plus London allowance of £60.

Further particulars from the Secretary.

NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD
FRESHWATER FISHERY RESEARCH

A vacancy exists for a Biologist, preferably with two or three years' research experience, to investigate the ecology of young salmon in a particular area in North of Scotland. Duration of appointment one year or possibly two years. Salary according to age and experience. Commencing date May, 1958.

Application form obtainable from the Secretary, 16 Rothesay Terrace, Edinburgh, 3, should be returned by April 5, 1958.

CHELSEA COLLEGE OF SCIENCE AND TECHNOLOGY
MANRESA ROAD, S.W.3
DEPARTMENT OF CHEMISTRY

The Governing Body invite applications for the post of Assistant Lecturer (Grade B) in Chemistry. Candidates should possess good academic qualifications and special experience in Physical Chemistry. Salary scale as follows: men, £650 by £25 to £1,025; women, £620 to £1,025 plus additions for training (men £25 to £75; women £20 to £60); graduate status (men £75; women £60), and London allowance of £36 or £48 according to age.

Particulars and form of application from the Clerk to the Governors, to whom applications should be submitted not later than April 25.

INSTITUTE OF DENTAL SURGERY
(UNIVERSITY OF LONDON)
EASTMAN DENTAL HOSPITAL,
GRAY'S INN ROAD, W.C.1

Technician required to assist in research in Biochemistry Laboratories. Experience in biochemical or microbiological techniques will be an advantage, but candidates with general laboratory training will be considered. Salary in accordance with age, qualifications and experience.

Further details, application forms, etc., from the Secretary.

MINISTRY OF LABOUR AND NATIONAL Service: H.M. Inspector of Factories. Pensionable posts for men or women. Age 23 and under 30 on June 1, 1958 (extension for regular Forces service, Overseas Civil Service, or exceptional qualifications). Duties include enforcing Factories' Acts, etc. Qualifications: normally science or arts degree or comparable technical qualification (e.g., A.M.I.Mech.E.). Industrial experience an advantage. Starting pay (London) £650 to £745. Maximum £1,030. Promotion prospects.

Write Civil Service Commission, 6 Burlington Gardens, London, W.1, for application form quoting 280.

D.E.R.E.

The following vacancies exist for

SCIENTIFIC STAFF

in the

EXPERIMENTAL REACTOR ESTABLISHMENT

of the United Kingdom Atomic Energy Authority, Industrial Group, at Dounreay, Thurso, Caithness, Scotland.

PLANNING OFFICER (Ref. 2357)
to be responsible for planning and progressing a part of the research, development and production programmes. Duties will include preparation of programmes, allocation of assessment of scientific effort, advice on procurement of apparatus, plant and equipment, and assistance with costing and budgeting.

H.S.C., or equivalent, with mathematics or a science subject as principal subject, experience in a research and development laboratory, a general rather than specialized knowledge of scientific matters and acquaintance with management techniques are required. Possession of a university degree may be an advantage. Normal minimum age 35 years.

Salary will be assessed within scale £1,360 to £1,630.

TECHNICAL EDITOR (Ref. 2358)
to ensure clear and logical presentation of written technical matter, including illustrations, submitted by scientific staff. This requires preparation of edited copy for printing, proof correction, and maintenance of records. Modifying existing documents with a view to their wider publication may be involved.

G.C.E. or equivalent, in at least five subjects, two of which must be at Advanced Level in science or mathematics, a good command of English and a knowledge of the problems involved in communicating information are required. Experience of editorial work and possession of a university degree are desirable. Normal minimum age 26 years.

Salary will be assessed within scale £990 to £1,215.

GENERAL EXPERIMENTAL POSTS
(a) to assist with and guide experimental effort in a team responsible for physics and allied experiments concerned with the Fast Reactor (Ref. 2353).

H.S.C., or equivalent, with mathematics or a science subject as principal subject and considerable experience of experimental physics are required. A knowledge of nuclear instrumentation would be an advantage. Normal minimum age 35 years.

Salary will be assessed within scale £1,360 to £1,630.

(b) to be a member of a team responsible for physics and allied experiments concerned with the Fast Reactor (Ref. 2351).

G.C.E., or equivalent, in at least five subjects, two of which must be at Advanced Level in science or mathematics and some experience in experimental physics are required. An understanding of experimental techniques is desirable and experience in nucleonics will be an advantage. Normal minimum age 26 years.

Salary will be assessed within scale £990 to £1,215.

(c) to be a member of a team responsible for reactor physics calculations. Some experimental work, particularly solving reactor problems by analogue techniques, may be involved (Ref. 2352).

G.C.E., as for previous post, and some experience of physics calculations are required. Possession of a degree in mathematics or mathematical physics may be an advantage. Normal minimum age 26 years. Salary as for previous post.

CONTRIBUTORY PENSION SCHEME

Housing at Thurso or hostel accommodation may be available. Substantial assistance towards removal expenses is given in certain cases.

Send postcard for application form, quoting appropriate reference, to Establishments Officer, D.E.R.E., Dounreay.

Closing date: April 14, 1958.

EMPIRE COTTON GROWING CORPORATION

Plant Pathologists, with some postgraduate experience, are required to investigate diseases of cotton in Africa. Salary, according to age and experience, on a scale from £939 to £1,863 per annum. Free quarters, leave passages for officer and family every two years, and staff assurance scheme to which the Corporation contributes the equivalent of 21 per cent of salary.

Applications, with names and addresses of two referees, to the Secretary, E.C.G.C., 12 Chantrey House, Eccleston Street, London, S.W.1.

CENTRAL WIRRAL GROUP
CLATTERBRIDGE HOSPITAL WEST, BEBINGTON, CHESHIRE

Physicist (basic grade) required for duties in new Radiotherapy Unit where the major equipment is a 4 MeV linear accelerator. Candidates must have honours degree in physics, but hospital experience not essential. There will be opportunities for development and research. Salary according to previous experience within the scale £625 by £25 (3) to £700, subsequently £800 to £1,000 per annum.

Further details and application form from Secretary, to be returned within 10 days of the appearance of this advertisement.

DURHAM COLLEGES IN THE UNIVERSITY OF DURHAM

Applications are invited for the post of Lecturer in Chemistry from October 1, 1958. The salary scale attaching to the appointment will be £900 to £1,650 a year.

Applications (three copies), together with the names of three referees, should be sent not later than May 1, 1958, to the Secretary, 38 North Bailey, Durham, from whom further particulars may be obtained.

UNIVERSITY OF MANCHESTER

There is a vacancy in the Computing Machine Laboratory for an Assistant (age 17-23) for miscellaneous duties in connection with the preparation of work for an electronic digital computer. Inter.B.Sc. or equivalent qualifications, including mathematics, required. Facilities available to attend approved courses of higher education. Salary in accordance with the University's scales, e.g., £4 10s. age 17, £7 11s. age 23.

Applications should be sent to Dr. T. Kilburn, Department of Electrical Engineering, The University, Oxford Road, Manchester, 13.

UNIVERSITY OF GLASGOW
ASSISTANTSHIP IN MATHEMATICS

Applications are invited for an Assistantship in Mathematics. Salary scale: £700 to £850. Initial salary according to experience and qualifications. F.S.S.U. and family allowance benefits.

Applications (three copies), should be lodged not later than April 26, 1958, with the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
Secretary of University Court.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING
(UNIVERSITY OF READING)

Applications are invited for the post of Head of the Feeding and Metabolism Department, which will become vacant on the retirement of Dr. S. Bartlett on September 30, 1958.

Further particulars from the Secretary, N.I.R.D., Shinfield, Reading. Quote ref. 58/8.

INSTITUTE OF PSYCHIATRY
UNIVERSITY OF LONDON

Biochemical Research Assistant for work in connection with the nervous system. Initial salary according to age, qualifications and experience (within the range £650 to £850). The appointment will be for one year in the first instance.

Application forms, to be returned within ten days, from Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5. (Ref. Bio.)

UNIVERSITY COLLEGE LONDON (GOWER Street, W.C.1) requires full-time Assistant Lecturer (Demonstrator) in Anatomy (Professor J. Z. Young) to undertake teaching and research. Duties to commence September 1, 1958, or earlier. Salary within the range £850 to £1,050 per annum, plus £60 London allowance. Superannuation and family allowance.—Applications, to be received by May 15, should be sent to the Secretary of the College, from whom further particulars may be obtained.

ROYAL TECHNICAL COLLEGE
SALFORD

Principal: C. Whitworth, M.Sc., Ph.D., F.R.I.C., F.Inst.F.

Required as soon as possible, Lecturer in Physics in this College of Advanced Technology. Candidates must have had some industrial research experience; teaching experience is desirable. The person appointed will be expected to continue with research work for which time and facilities will be available. The salary will be in accordance with the Burnham Scale for Lecturers (£1,200 to £1,350 (men); £960 to £1,080 plus 4/7ths differential (women)), and the initial salary will be determined by previous industrial, research or professional experience.

Further particulars and forms of application may be obtained from the Principal, Royal Technical College, Salford, 5, to whom they should be returned as soon as possible.

R. RIBBLESDALE THORNTON,
Clerk to the Governors.

WEST MIDLANDS GAS BOARD
SENIOR ASSISTANT—FUEL SECTION

A vacancy has occurred in the Area Chief Chemist's Department, located in Birmingham, for a Senior Assistant, Fuel Section. Candidates should possess the higher national certificate in chemistry or an equivalent qualification and have an interest in statistical method. The salary will be within the range of Grades APT 8-9 (£745 to £895 per annum) of the National Salary Scales for Gas Staffs. The post is pensionable and the successful candidate may be required to pass a medical examination.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6 Augustus Road, Edgbaston, Birmingham, 15, to reach him not later than April 9, 1958.

J. SWAN,
Secretary to the Board.

KENT EDUCATION COMMITTEE
NORTH-WEST KENT COLLEGE OF TECHNOLOGY

Science Department, Assistant (Grade B), required immediately to teach chemistry, with some physics or mathematics. Salary will be in accordance with the Burnham Technical Report, 1956, on the £650 by £25 to £1,025 scale.

Application forms and further particulars may be obtained from the Principal at the College, Miskin Road, Dartford.

UNIVERSITY OF LONDON.—The Senate invite applications for the Readership in Mechanical Engineering tenable at the Imperial College of Science and Technology (salary scale £1,475 to £1,775 to £2,150 a year plus £80 London allowance).—Applications (ten copies) must be received not later than May 1, 1958, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars may be obtained.

B.I.S.R.A. HAVE VACANCIES AT THEIR Swansea laboratories for graduate and non-graduate research staff with qualifications in physics, electrical engineering, metallurgy or chemical engineering. The work includes fundamental and applied research directed to the development of new finishing processes for steel sheet and strip. New methods of making plastic-coated steel and for the continuous coating of strip with hot metal at high line speeds are at an advanced stage of development, and original metallurgical and electrochemical processes for treatment of steel are being evolved. There is much scope for imaginative research workers. Applications are sought from young men with initiative and drive and who are seeking opportunities to demonstrate and develop their abilities in industrial research. Good starting salaries are offered and very congenial working conditions with excellent opportunities for promotion in this progressive research organization. —Written applications only, quoting "S.W.5," to the Personnel Officer, The British Iron and Steel Research Association, 11 Park Lane, London, W.1.

STATISTICIANS, HOME CIVIL SERVICE. Postgraduate academic qualifications in statistics or good honours degree including statistics by summer 1958. Selection by interview. Age at least 20½, under 34 (in some cases 28) on August 1, 1958 (extension for service in H.M. Forces or Overseas Civil Service). Salary £635 to £1,110 and after promotion scale rises to £2,050.—Write Civil Service Commission, 6 Burlington Gardens, London, W.1, for application form, quoting No. 96/58/7. Closing date, May 22, 1958.

BRISTOL EDUCATION COMMITTEE
COLLEGE OF TECHNOLOGY

The governors invite applications for following posts:

DEPARTMENT OF CHEMISTRY AND BIOLOGY

SENIOR LECTURER IN ORGANIC CHEMISTRY
LECTURER IN ORGANIC CHEMISTRY
LECTURER IN INORGANIC CHEMISTRY
LECTURER IN PHYSICAL CHEMISTRY

Applicants must possess good academic and/or professional qualifications preferably with industrial or research experience in: Chemical Engineering, Biochemistry, Analytical Chemistry or Metallurgical Analysis.

LECTURER and TWO ASSISTANTS (GRADE B) in BIOLOGICAL SUBJECTS

Applicants must possess good academic qualifications and preferably have industrial experience in Biochemistry, Microbiology, Entomology or Plant Physiology.

DEPARTMENT OF PHYSICS AND MATHEMATICS

LECTURERS (three) in MATHEMATICS

Applicants must possess Honours Degree in Mathematics or Engineering with industrial or research experience involving applications of mathematics to engineering or scientific problems.

Experience in statistical work required in one post.

LECTURER in PHYSICS

Applicants must possess Honours Degree in Physics and industrial or research experience in a branch of applied physics, preferably Electronics or Nuclear Physics.

Burnham Technical Scale Salaries:
Senior Lecturer (man), £1,350 by £50 to £1,550.
Lecturer (man), £1,200 by £30 to £1,350.
do. (woman), £960 by £24 to £1,080.
Grade B (man), £650 by £25 to £1,025.
do. (woman) £580 by £20 to £820.

with graduate, training, and equal pay additions as appropriate. Consideration given to previous experience in fixing initial salary.

Application forms and details from Registrar, College of Technology, Bristol, 7.

UNIVERSITY OF NEW ENGLAND
AUSTRALIA

Applications are invited for appointment as Senior Research Fellow in Physics. The Fellow will be required to undertake a programme of experimental or theoretical research, preferably but not necessarily in the field of ionization and discharge physics or of solid state physics. Other things being equal, a Theoretical Physicist would receive preference. Applicants should give an outline of the work they wish to undertake. The appointment will be initially for three years with the possibility of extension for a further two years; salaries are at present under review, and it is expected that the salary for a Senior Research Fellow will be of the order of £A.2,000 per annum.

The conditions of appointment and other information may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close, in Australia and London, on May 26, 1958.

MARYFIELD HOSPITAL
DUNDEE

Applications are invited from graduates, or students expecting to graduate this year (honours degree preferable but not essential), for appointment as Basic Grade Biochemist in a rapidly expanding department with university connections. The Unit has recently moved into new laboratories. Salary scales: first-, second-class honours, £625 to £1,000; other entrants, £550 to £1,000 per annum.

Applications to Medical Superintendent, from whom further particulars may be obtained.

UNIVERSITY OF GLASGOW
RESEARCH FELLOWSHIP IN MATHEMATICS

Applications are invited for a Research Fellowship in Mathematics. Salary scale: £700 to £850. Initial salary according to experience and qualifications. F.S.S.U. and family allowance benefits.

Applications (three copies), should be lodged not later than April 26, 1958, with the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
Secretary of University Court.

ELECTRICAL RESEARCH ASSOCIATION

has two vacancies for graduates on the research staff of the Rural Electrification Section.

(a) To work on problems concerned with the application of electricity in AGRICULTURE. Applicants should possess a good degree in electrical or mechanical engineering.

(b) To work on problems concerning the applications of electricity in HORTICULTURE. Applicants should possess a good degree in electrical engineering or physics, and some knowledge of electronics.

Previous industrial or research experience would be an advantage for either post.

Starting salary will be in the range £650 to £900 per annum according to experience and qualifications. The posts are subject to Superannuation under F.S.S.U.

Applications should be addressed to the Head of the Rural Electrification Section, E.R.A. Field Station, Shinfield Green, near Reading, Berkshire.

UNIVERSITY OF MANCHESTER

Applications are invited from graduates for the post of Assistant Lecturer in Psychology. Candidates should have special interests or training in experimental and statistical psychology. Applications will be considered from candidates who intend to graduate in 1958. Salary on a scale £700 to £850 per annum with membership of the F.S.S.U. and children's allowance scheme.

Applications should be sent not later than April 19, 1958, to the Registrar, the University, Manchester, 13, from whom forms of application and further particulars may be obtained.

APPOINTMENTS VACANT

BRITISH THOMSON-HOUSTON CO. LTD.

The British Thomson-Houston Co. Ltd. has vacancies in its Research Laboratory at Rugby for graduates in physics to join a small research group working on techniques for processing silicon for device investigations, and on the development and study of new devices. Experience in this field is not essential and new graduates are invited to apply.

Applications should be made to the Director of Research, The British Thomson-Houston Co. Ltd., Rugby, giving age, qualifications, etc., and quoting reference WI.

WHITBREAD'S BREWERY HAVE A vacancy in their Research Laboratory for a first-class qualified Biochemist or Biologist to study yeast and fermentation problems.—Apply, giving qualifications and experience, to Chemist-in-Charge, Research Laboratory, The Brewery, Chiswell Street, E.C.1.

A GRADUATE PHYSICIST WITH RE-search experience is required by British Cellophane Limited, Bridgwater, Somerset. The work will be on laboratory investigations of an applied and fundamental nature into physical processes to supplement the work of an electronic section.—Write to Personnel Officer, quoting Ref. No. R72.N.

EDWARDS HIGH VACUUM LIMITED, Manor Royal, Crawley, Sussex, have a vacancy for the following: Translator/Abstractor, with at least two languages (German and French) and a sound technical background. Applicants (24-28) —male or female—should preferably hold a degree and be capable of translating into correct technical English. Salary will be dependent on qualifications and experience. Housing available if from London area.—Write, giving full details, to the Personnel Manager.

DEVELOPMENT ENGINEER REQUIRED with experience of rotary pumps, diffusion pumps, also instrumentation and allied equipment as used in high vacuum techniques, to form development section in company recently moved to new location. The position offers scope and interest to a man with the right technical background and experience, who will achieve results with a minimum of supervision.—Write, giving full details of previous experience, to The General Manager, N.G.N. Electrical Ltd., Avenue Parade, Accrington, Lancs.

FISONS LIMITED

ASSISTANT TECHNICAL OFFICER

The Fertilizer Division of Fisons Limited requires an ASSISTANT TECHNICAL OFFICER in the Planning Group of the Production Department at their Head Office in Felixstowe. The Planning Group forms part of the Technical Section and is responsible: for the technical planning of production resources so as to ensure optimum usage of plant and equipment; for the long term planning of additional production capacity; and for the general integration of technical effort as applied to production.

Applicants should have a sound technical training with a university degree in chemistry, physics, chemical engineering, engineering, or mathematics, and should preferably have had production experience; familiarity with the techniques of operational research would be a distinct advantage. Capacity for independent thought is of more importance than high academic attainment; ability to approach investigations with tact and discretion is essential. Salary according to qualifications and attainment. The Company operates a pension scheme.

Applications to Personnel Officer (GR10), Fisons Limited, Harvest House, Felixstowe, Suffolk.

PARKE, DAVIS & COMPANY, LIMITED

Applications invited from PHARMACOLOGISTS and BIOMETRICIANS for posts in the new Department of Pharmacological Research which is being set up to take part in the search for new pharmaco-dynamic agents. In the new laboratories, which are at present being built, both short- and long-term research projects will be undertaken. Posts at various levels of qualification and experience are open, and applications are invited for those with Ph.D., M.Sc., B.Sc., or equivalent degrees.

A five-day week is worked, and there is a generous pension and life assurance plan.

Applications should be addressed to the Director of Pharmacological Research, PARKE, DAVIS & COMPANY, LIMITED, STAINES ROAD, HOUNSLOW, MIDDLESEX.

T. WALL & SONS LTD.

is expanding its activities and invites applications for the following posts which have been created to deal with the problem.

1. Bacteriologist, male, to act as Assistant to Chief Bacteriologist. Age 28 to 35 with experience of food bacteriology preferred. (Acton.)
2. Physical Chemist to carry out research work in connection with wide range of food products. Honours degree and some research experience desirable. (Acton.)
3. Chemist to take charge of routine laboratory in meat products factory. Experience in food analysis and knowledge of food bacteriology. (Hayes, Middx.)

The salaries offered will be in accordance with age and experience and conditions are those of a progressive company.

Applications should be addressed to the

Group H.O. Personnel Manager,
T. Wall & Sons Ltd.,
The Friary,
London, W.3.

LOUIS NEWMARK LIMITED REQUIRE A Development Engineer for work on Aircraft and Industrial Instruments in their Laboratory at New Addington. Candidates should preferably have a degree and have some experience of either Capsule type instruments or servo engineering. Pension scheme.—Please apply, in writing, to Personnel Officer, Louis Newmark Ltd., Purley Way, Croydon, Surrey.

FATSTOCK MARKETING CORPORATION LTD.

Expanding subsidiary group handling and processing animal by-products requires qualified chemist. This is a progressive position with prospects of advancement to a more senior appointment. Duties will be primarily concerned with analysis and quality control of existing products and assisting management in improving present handling methods. Duties will also include keeping abreast of technical developments in the animal by-products field. Applicants should have an honours degree in chemistry, with knowledge of bacteriology, and have had at least five years' industrial experience with a commercial organization. The commencing salary will be according to qualifications and will be subject to annual review. Participation in the pension scheme.

Applications should be made to the Personnel Manager, F.M.C. Ltd., Agriculture House, 25/31 Knightsbridge, S.W.1.

JOSEPH LUCAS (ELECTRICAL) LIMITED

MATHEMATICIAN

required for interesting analysis work in connection with the development of electro-mechanical devices. The work covers the analysis of stress, vibration, and acoustical phenomena and the interpretation of test results.

Candidates should have a degree in mathematics or mathematical physics together with some experience of applying mathematics to engineering or design problems.

The position is pensionable and provides a good starting salary. Apply, in writing, stating age, qualifications and experience, to the Personnel Manager, JOSEPH LUCAS (ELECTRICAL) LIMITED, Great King Street, Birmingham, 19, quoting reference PM/D/200.

RESEARCH ASSOCIATION OF BRITISH Rubber Manufacturers, Shawbury, Shrewsbury, require in their Intelligence Division, the services of a chemist or physicist (graduate or equivalent qualification) for literature research, etc. Excellent opening for young graduate desiring career in scientific information work. Appointment will be on the Technical Officer scale (£515 by £35 to £830) with starting salary according to age and qualifications. Pension scheme. Five-day week. —Apply to Secretary.

ASSISTANT RESEARCH CHEMIST, AGE 26-35. Ph.D. (chemistry). Previous experience in colloid chemistry essential. Good commencing salary. Bonus and pension schemes. Please write, giving details of age and experience, to Chief Chemist, Research and Manufacturing Laboratories, The National Cash Register Co. Ltd., 14 Warwick Road, Boreham Wood, Herts.

PHYSICAL CHEMISTS. SUITABLE CANDIdates would be men or women with first- or upper second-class honours degrees in chemistry with up to five years research experience in physical chemistry. There are two positions to be filled in the first instance, for which the detailed requirements are: (A) Experience in polymer chemistry or paper chemistry. (B) Experience in modern analytical methods, spectroscopic techniques or the physics and physical chemistry of aerosols and smokes. Candidates with qualifications for either of these types of work are invited to apply. The Research and Development Establishment is pleasantly situated on the west side of Southampton, within easy reach of the New Forest and runs its own canteen. A five-day week and contributory pension scheme are in operation. The Establishment is relatively new and the prospects for a keen and hard worker are excellent.—Applications should be addressed to Personnel Department, British-American Tobacco Co., Ltd., Westminster House, P.O. Box 482, 7 Millbank, London, S.W.1.

PROJECT LEADER OF SMALL TEAM TO develop a high precision frequency standard based on Ammonia Maser. First- or second-class honours physics with at least five years' experience in microwave and electronic engineering. To control project up to and including production. Well-established company, pension scheme, etc. From £1,200.—G.D., Ltd., Sudbourne Road, S.W.2.

BRITISH TITAN PRODUCTS COMPANY LIMITED

have vacancies for

CHEMISTS AND CHEMICAL ENGINEERS

at their

TECHNICAL HEADQUARTERS, BILLINGHAM, CO. DURHAM

The Company is primarily concerned with the large-scale manufacture of titanium dioxide and is characterized by a ten-fold expansion in post-war years. This continuing expansion is associated with a multiplicity of chemical and chemical engineering problems which can provide an interesting and worthwhile job in well equipped laboratories and pilot plants.

Applications are invited from first- or second-class honours degree graduates for the above vacancies in the Research and Technical Departments. Some industrial experience is preferred but fresh graduates, including those at present engaged on National Service, etc., and who will be available some time in 1958, may also apply. The age range envisaged is 25 to 35 years.

Salaries and prospects are very attractive for men with the right qualities: conditions of work are good: Staff Bonus, Superannuation Scheme and non-contributory Life Assurance are in operation; housing assistance is available if required.

Applications will be treated in the strictest confidence and should be addressed to the Personnel Manager, British Titan Products Co. Ltd., Coppergate, York, quoting reference S.33.

BRITISH PETROLEUM COMPANY LIMITED has vacancies for HONOURS GRADUATES for work at its Exploration Laboratories at SUNBURY-ON-THAMES. Applicants should have fulfilled their National Service obligations. Applications are invited from candidates with the following qualifications:

(a) Honours Graduate in Chemistry for work on the analysis of petroleum and sedimentary rocks using microanalytical and chromatographic techniques. (Ref. H.3682B.)

(b) Honours Graduate, B.Sc. or B.Eng., preferably with a research qualification for work on measurements concerned with the flow of fluid in porous rocks. Research work is directed to new methods of oil recovery. (Ref. H.4334.)

Salaries according to age, qualifications and experience, non-contributory Pension Fund, assisted House Purchase Scheme, removal expenses and settling-in allowances payable in certain cases, Luncheon Club.—Write, giving full particulars, quoting appropriate Reference Number, to Box 5718, c/o 191 Gresham House, E.C.2.

CHEMISTS, PREFERABLY WITH HONOURS degree, required by The British Drug Houses Ltd for Development Research in connection with organic chemicals. The work relates to bulk and fine chemicals and chemotherapeutic substances. Commencing salary will be according to qualifications and experience. Five-day week. Pension and profit sharing schemes. Canteen and sports club.—Apply, in writing, stating age, qualifications, experience and salary required, to Staff Manager, Graham Street, City Road, N.1.

ANALYTICAL CHEMIST REQUIRED FOR shift work in Control Laboratories of a chemical works. Applicants should be at least 18 years of age and preferably have had two years' industrial laboratory experience. Minimum qualifications G.C.E. in chemistry, physics and mathematics (chemistry preferably at advanced level). Facilities for part-time study at recognized technical college courses. Salary according to qualifications, experience and age. Pensionable post. Lodging accommodation arrangeable.—Write (quoting No. 1395), to Personnel Manager, Fisons Pest Control Limited, Harston, Cambridge.

PHILCO CORPORATION

The Philco Corporation Research Laboratories in Philadelphia, Pennsylvania, offer exceptional opportunities for Experimental Physicists, Engineering Physicists, and Metallurgists interested in the growth of Crystals, Electrical and Optical Properties of Semi-conductors, and Advanced Semi-conductor Devices.

Experience in Solid State Physics or Transistor Technology desirable, but not essential. Qualifications : Ph.D. degree desirable, but recent graduates are invited to apply. Nationality immaterial but good knowledge of English essential. Salaries commensurate with American Industrial Standards.

Applications, that will be handled with strictest confidence, giving full educational details and professional interests, are to be sent Air Mail to :

Mr. C. V. Bocciarelli,
Assistant Director of Research,
Solid State Electronics,
PHILCO CORPORATION,
"C" and Tioga Streets,
Philadelphia 34, Pennsylvania,
United States of America.

Promising applicants will be invited to attend interviews in London or principal continental centres, during May.

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Please send details of qualifications, experience and publications to R. A. Denerley at the address below, quoting reference U.793. No information will be disclosed to our client until candidates have been told the company's identity and have given permission after confidential discussion.

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DUNLOP RUBBER COMPANY LTD. Require a Technical Assistant for the information section of their Patents Department. Work includes patent searching and classification, and applicants should have some chemical knowledge, preferably but not necessarily a degree. Knowledge of French or German would also be an advantage. —Please write in confidence, giving brief details and commencing salary expected, to Personnel Manager (JM 143), Fort Dunlop, Erdington, Birmingham, 24.

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ENTOMOLOGIST REQUIRED BY PYRETHRUM Board of Kenya to assist the Senior Entomologist in the Research Department at Nakuru, Kenya. The work involves insect breeding and the bioassay of new pyrethrum formulations for toxic activity. The post would suit a fresh graduate in entomology with subsidiary zoology/Physiology/Chemistry, preferably, but not necessarily, with some experience in this field. Publication of work is encouraged. Nakuru has an altitude of 6,000 ft. and the climate is very pleasant, healthy and temperate. Tour, five years two months in first instance: eighteen days local leave per annum with two months' study leave in U.K. each two and a half years. Return air passages for family up to three adult passages. Medical insurance and provident fund. Hard-furnished house or flat at rental not more than 15 per cent of salary. Salary: £1,200 to £1,300 per annum with £50 per annum increments.—Please reply without delay to Box No. 637, T. G. Scott and Son, Ltd., 1 Clements' Inn, London, W.C.2.

GRADUATE SCIENTIST (PREFERABLY physicist) required in the Information Department of the British Scientific Instrument Research Association, "Sira," South Hill, Chislehurst, Kent. Main duties: answering technical inquiries on the basis of published information; literature surveys; abstracting.—Intending applicants should write for full details to Head of Information Department.

BIOCHEMIST (MALE). BEECHAM Research Laboratories Limited require a suitably qualified young graduate in their Biochemistry Department to assist in investigations of the metabolic fate of new drugs. Salary according to age, qualifications and experience. Bonus and non-contributory pension schemes in operation.—Apply to Assistant Director of Research, Beecham Research Laboratories Ltd., Brockham Park, Betchworth, Surrey.

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LABORATORY ASSISTANT (FEMALE) REquired at Chesterford Park Research Station, near Saffron Walden (Essex), age not less than 18, preferably with G.C.E. "O" level, including chemistry and mathematics but not essential. Good conditions of employment and canteen. Lodging accommodation arrangeable. Salary according to qualifications, age and experience.—Write (Quoting No. 1397), to Personnel Manager, Fisons Pest Control Limited, Harston, Cambridge.

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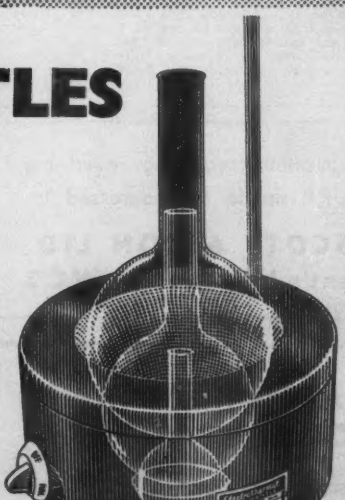

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The Committee will, in July, allocate a limited number of Grants-in-Aid for the purchase of books, for library subscriptions or other necessary purposes, to young men and women employed in chemical works in or near London, who desire to extend their education for a career in chemical industry. Applicants must have general certificate of education at advanced level in chemistry or Intermediate B.Sc., or their equivalent. Applications should be made as soon as possible, whereupon forms will be issued requiring particulars of age, nature of employment and the manner in which the Grant would be used.

The application forms should be received, completed, before May 14, 1958, by: The Clerk of the Salters' Company, Salters' Institute of Industrial Chemistry, 36 Portland Place, London, W.1.

IMPERIAL COLLEGE: ENGLISH ELECtric Studentship for research in aeronautics. Value £750, out of which fees must be paid.—Further particulars from the Registrar, Imperial College, London, S.W.7. Closing date, May 17, 1958.

IMPERIAL COLLEGE: BURSARY OF £425 out of which fees must be paid, provided by a group of optical instrument firms, available for one year for the postgraduate course in Technical Optics.—Further particulars from the Registrar, Imperial College, London, S.W.7. Closing date, June 2, 1958.

THE GAS COUNCIL

RESEARCH SCHOLARSHIPS

The Gas Council invites applications for five Research Scholarships from graduates or prospective graduates in physics, chemistry or engineering at British Universities. The scholarships will be awarded for a period of three years from September 1, 1958, and the Universities in which they will be tenable are as follows: University of Oxford, Departments of Chemistry. University of Cambridge, Department of Chemical Engineering. University of London, Department of Chemical Engineering at either the Imperial College of Science and Technology or University College; Department of Chemistry at the Imperial College of Science and Technology. University of Durham, Department of Chemical Engineering at King's College, Newcastle. University of Manchester, Departments of Chemistry and Chemical Engineering at the Manchester College of Science and Technology. University of Birmingham, Department of Chemical Engineering. University of Glasgow, Department of Chemistry. The subject proposed for research must afford scope for original work and be of a character approved by the Research Committee of the Gas Council which is interested in problems related to the manufacture, distribution or use of gas. Each scholarship will carry an allowance at the rate of £400 a year together with the payment of University and College fees.

Particulars and application forms may be obtained from the Secretary, the Gas Council, 1 Grosvenor Place, London, S.W.1, or from the Head of any one of the University Departments named above. Applications should be submitted on or before May 1, 1958, to the Secretary, the Gas Council, or, if the candidate is a student in one of the University Departments named above, to the Head of that Department.

ANIMAL HEALTH TRUST

RESEARCH TRAINING SCHOLARSHIPS, 1958

Two or three Research Training Scholarships will be offered by the Animal Health Trust. These Scholarships, to the value of £400 to £500 per annum (exempt from income tax) depending upon the location and on the marital status of the successful candidate, are available to recently qualified veterinary surgeons and final-year students (subject to July examination results) who are desirous of undertaking further specialist study or supervised research to fit them better for an academic, research, or specialist career. In addition a sum not exceeding £60 per annum may be given towards the payment of essential fees. The awards will be made in June.

Forms of application can be obtained from The Scientific Director, The Animal Health Trust, 14 Ashley Place, Westminster, London, S.W.1. The closing date for the receipt of applications is Monday, April 28, 1958.

UNIVERSITY OF SHEFFIELD

Three Postgraduate Research Bursaries are available in the Department of Fuel Technology and Chemical Engineering, two for work on the physics and physical chemistry of combustion in bench type rigs and the third for research on the physical chemistry of soot formation in large flames, to be carried out primarily at the International Flame Radiation Centre at Ijmuiden. Value in the range £350 to £500 per annum plus fees.

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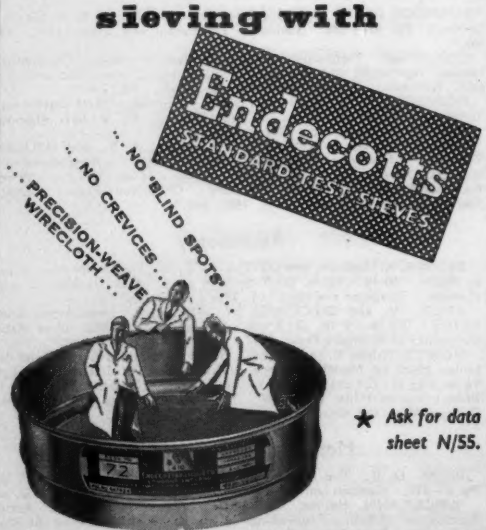

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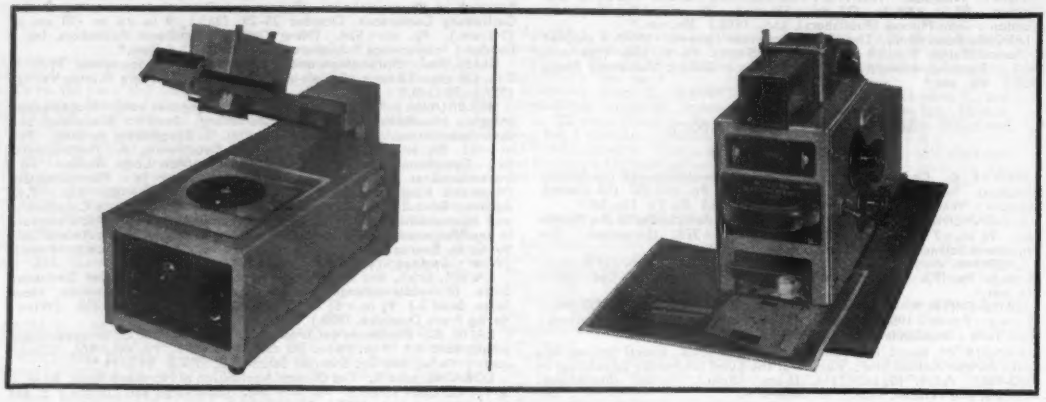

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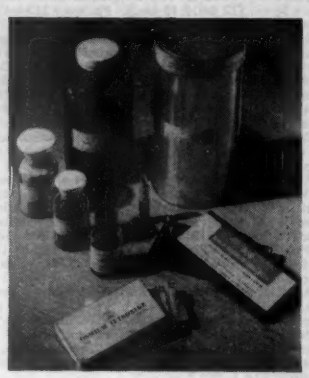

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